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Central Station Service for Manchester, N. H.

HYDRO-ELECTRIC AND STEAM STANDBY STATIONS OF THE MANCHESTER TRACTION, LIGHT & POWER CO.

SUPPLYING CURRENT for traction power to the street railway company; for light, to offices and private homes and streets; and for power to the industrial plants in the city of Manchester, New Hampshire, and its environs is the business of the Manchester Traction, Light & Power Co., a public utility organization serving the valleys of the Merrimack and Piscataquog rivers around Manchester.

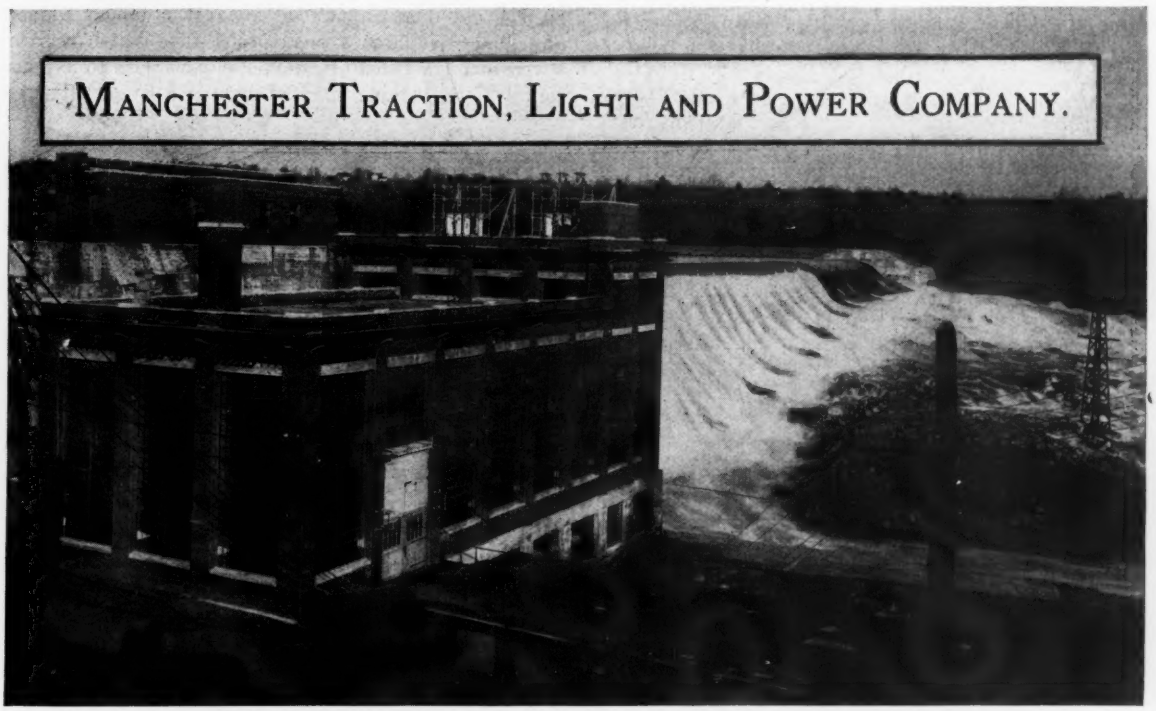


FIG. 1. GREGG'S FALLS DAM AND POWER HOUSE FROM THE SOUTH BANK OF THE PISCATAQUOG

Current for this service is generated in a number of hydro-electric stations on the Merrimack and its tributaries and at a steam standby station at Kelley's Falls on the Piscataquog.

The stations of the Manchester Traction, Light & Power Co. located at Garvin's Falls near Concord, and Hooksett Falls, Hooksett, both on the Merrimack River, and Gregg's Falls in Goffstown, and Kelley's Falls at Manchester, both on the Piscataquog River, all concentrate their energy at the Kelley's Falls station over the 33,000-v. transmission lines. From Kelley's Falls station the current is carried by two 33,000-v. circuits to the Brook St. sub-station for distribution in and about Manchester. The current is also transmitted from Kelley's Falls station to Nashua by two 33,000-v. circuits. The system is also connected with that of the New England Power Co. at the Nashua sub-station. The system supplies the cities of Manchester and Nashua, also the towns Derry, Suncook, Hooksett, Goffstown, and other towns within a territory about 30 mi. long by 12 mi. wide with Manchester as its center. The system is also connected with the power houses of the Concord Electric Co., the Amoskeag Manufacturing Co., and the McElwain Co., for the interchange of energy in cases of emergency.

Of particular interest are the Gregg's Falls and Kel-

ley's Falls plants, designed by Hollis French and Allan Hubbard, consulting engineers; the first, because it is a new plant getting more power from the river than that which was being obtained on the same site by an old

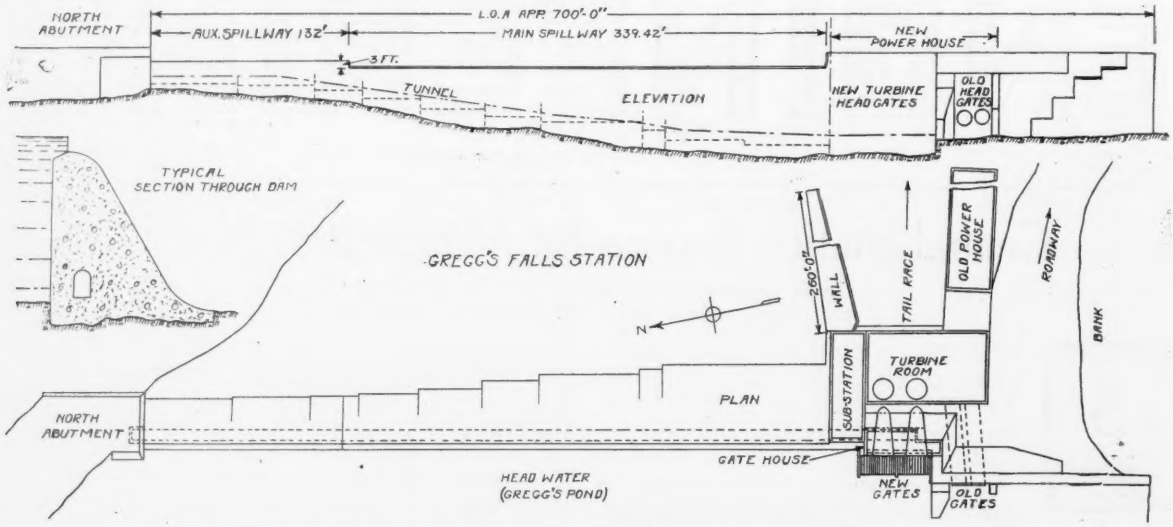


FIG. 2. PLAN AND ELEVATION OF THE DAM AND STATION

plant which it replaced; and the second because it is a rather unusual, combination plant containing both hydraulic and steam units.

Gregg's Falls

The Gregg's Falls plant is located about 6½ mi. northwest of the city on what is locally known as the "Squog" River on a site which had previously been developed. The old installation was fast reaching a state of obsolescence; more efficient units were required as the total normal flow of the river was then utilized and the power requirements on the system were increasing. In addition to these considerations, the old wooden crib, stone filled dam was becoming weaker and less stable with age and it was feared that during some freshet it might break down and be carried away.

The old dam impounded an area of about 84 acres and made available a head of 51 ft. Water was conveyed through two 10-ft. diameter penstocks to five horizontal 27-in. turbine runners driving a single alternator

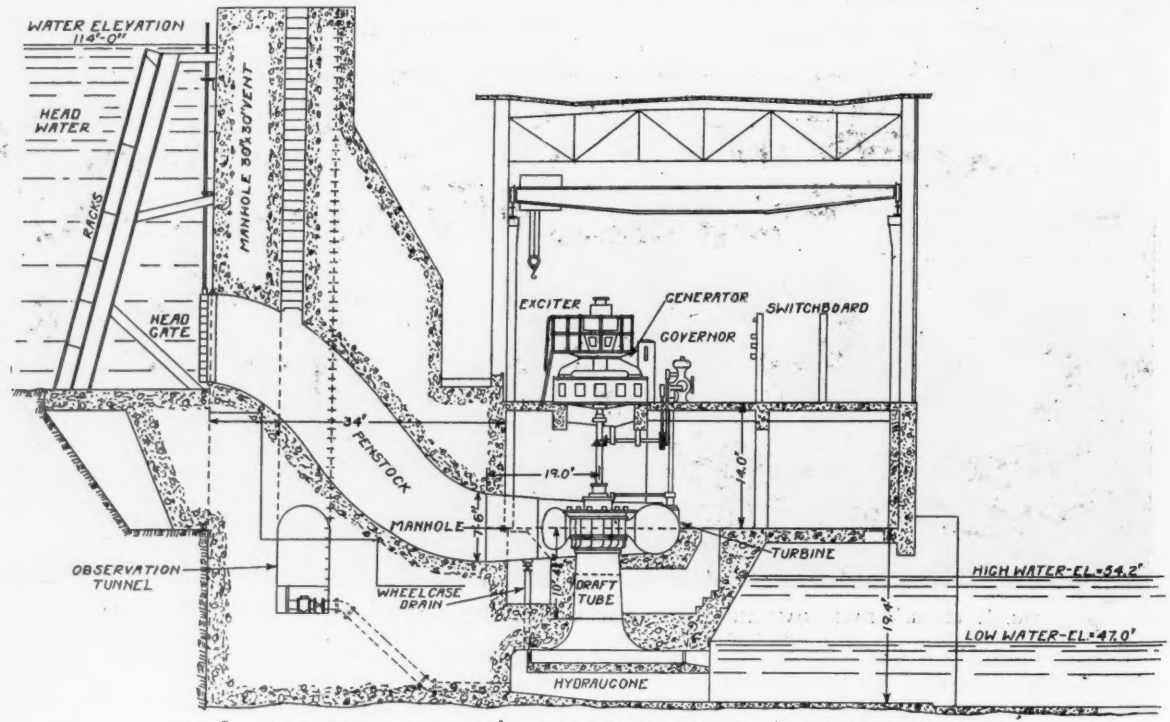


FIG. 3. CROSS SECTION OF GREGG'S FALLS PLANT SHOWING LOCATION OF MAIN UNIT

between them. One penstock supplies three wheels and the other, two wheels.

In building the new installation, the old one, including the dam, was left intact and was kept in service

throughout the process of construction. Even now the old plant is standing and in operating condition, ready to be put on the line when occasion demands.

over the crest. It is located down stream from the old one, the up-stream face being as close to the base of the old structure as it was possible to make it. This face

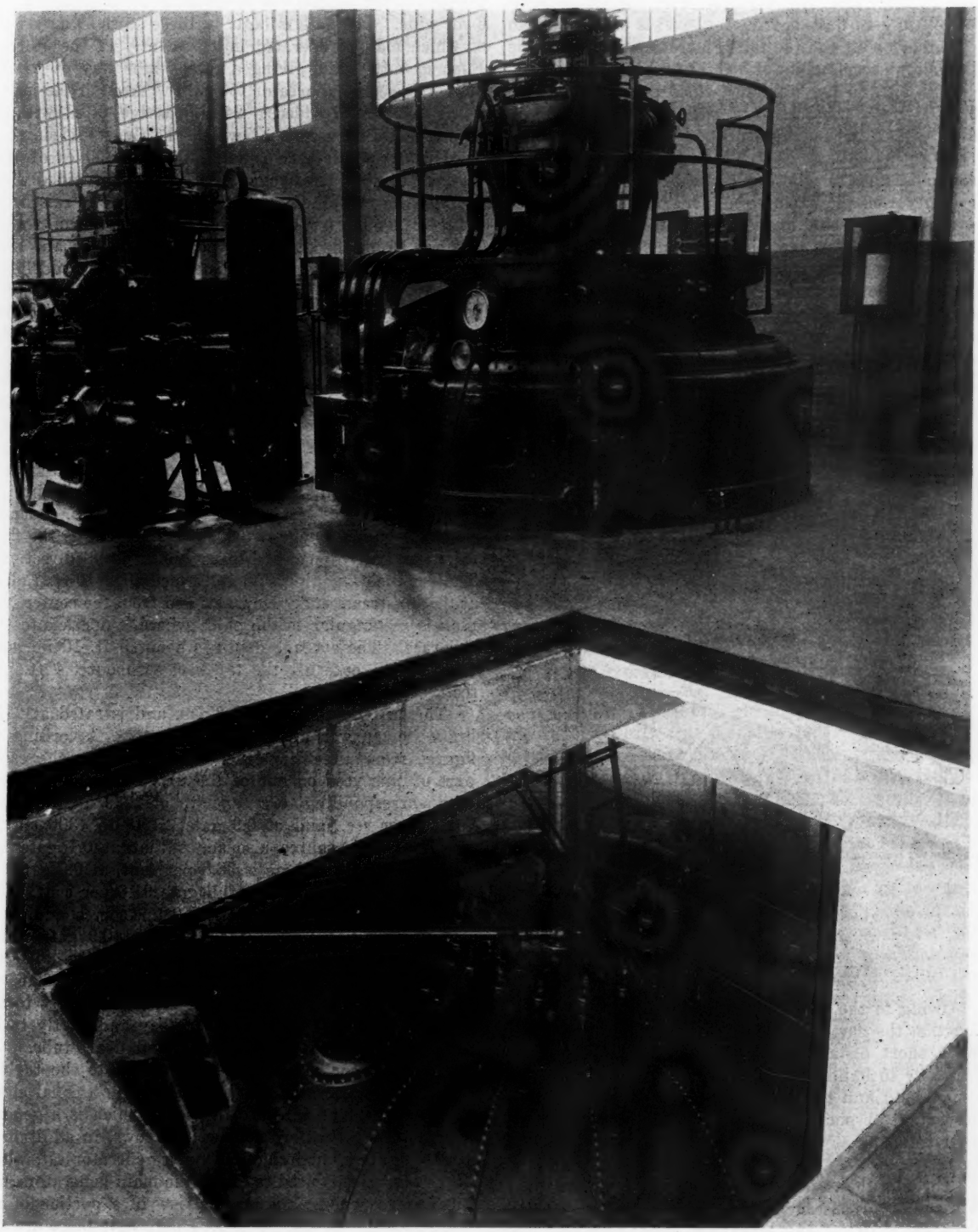


FIG. 4. ONE OF THE MAIN GENERATORS AND ITS TURBINE AT GREGG'S FALLS

The new dam is of the Ogee type, 700 ft. long and constructed throughout of concrete. This type of construction gives it ample stability and is designed to discharge a maximum volume of water for a given head is vertical, the crest is rounded and the back is built to an Ogee curve with steps near the bottom to break the velocity of the fall over the spill. The curve of the back of this structure and its effect on the flow is well illus-

trated in Fig. 1, in which is also shown a view, from the south bank, of the station and the head gate house.

From the spillway crest to tailwater, the drop is 60 ft., 10 ft. more than was available with the old installation. With 3-ft. flash boards, the level is brought up to the auxiliary spill and the fall is increased to 63 ft. The design allows a maximum of 5 ft. of flashing on the main spill and 2 ft. on the auxiliary which gives a maximum fall of 65 ft. Permanent 5-ft. flash boards are now installed, giving the maximum fall.

Due to the increased head, there is an increase in the power available, for the same rate of flow of about 26 per cent. For the same sized penstock, the increased power available would amount to about 41 per cent. In addition to this, the new dam impounds a considerably greater volume of water and as a consequence, variations in the flow of the river are not as keenly felt. The present reservoir covers an area of approximately 139 acres, resulting in an increased volumetric capacity of about 70,000,000 cu. ft.

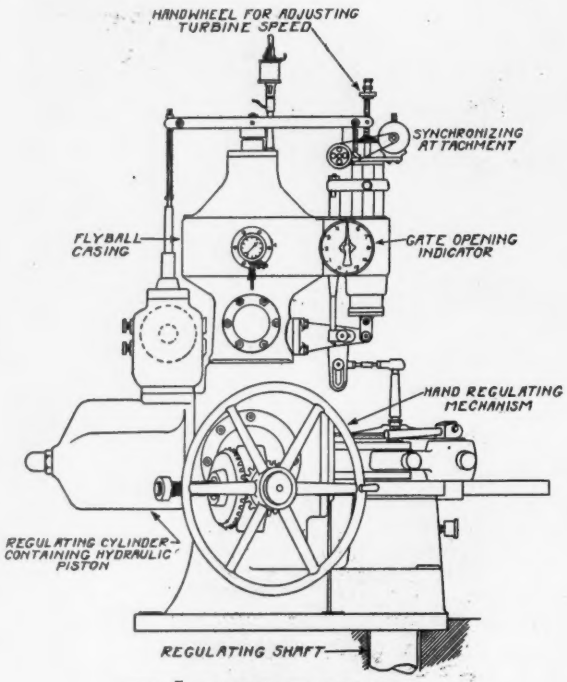


FIG. 5. GOVERNING MECHANISM

Owing to the added height in the pond, and to the fact that the north bank of the river is rather low-lying for a short distance upstream from the dam, it was necessary to build an embankment or dyke between the higher land and the end of the dam in order to retain the water. A portion of this dyke and the character of the river bank at this point is shown in the view of the dam.

Through the interior of the dam, near the base, there is a tunnel or passageway which is used for inspection purposes to detect any leaks that might manifest themselves. At the south end of the dam is the head gate house, and, directly below, the station and substation.

In Fig. 3 may be seen a sectional elevation, and in Fig. 2 a plan view of the site. Here there are two Allis-Chalmers Mfg. Co. single runner, vertical type, hydraulic turbo-generator units. Fifty-one feet below the forebay level with 3 ft. of flashing is the center line of the wheel casing. Thirty feet below is the center line of the penstock where it opens into the head waters. At this point, the concrete penstock is 10 ft. high by 17 ft. 6 in. wide. The gate is built in three sections, any one of which may be operated independently of the others. Each is 5 ft. wide, giving a total water way of 15 ft. or a cross sectional area of 150 sq. ft. Around the main gates there is provided a 24-in. passage fitted with a sliding gate, by means of which the penstock may be filled and the pressure equalized on both sides of the gates before they are opened. Each gate is provided with a single screw spindle at its center which is raised or lowered through a spur gear nut by a remote controlled motor. From the gates, the penstock follows an "S" or Ogee curve downward a distance of 21 ft. and horizontally, 34 ft. to the turbine wheel casing. The section is gradually reduced until at the entrance to the turbine it has a diameter of 7 ft. 6 in. or an area of 44.2 sq. ft.

From the wheel casing to low tail water, the drop is 12.5 ft. through a White hydraucone regainer. The section of this tube gradually increases from a diameter of 4 ft. 9 in. at the casing where, at full gate the velocity is about 20 ft. per sec., to 5 ft. 10½ in. at a distance of 10 ft. 4¾ in. below the center line of the runner. From this point the walls flare to horizontal in a distance of 3 ft. 1¼ in. Nineteen inches below is a 12-in. concrete slab that builds up the hydraucone and deflects the flow from vertically downward to horizontal in all directions. The pit inclosing this slab is formed to a 10-ft. radius at the up-stream end. Down stream from the center, the plan is rectangular to the point where it opens into the tail race. The average depth is about 5 ft. 10 in., and the velocity, entering the tail race is about 3.4 ft. per sec.

The turbine runs at 257 r.p.m. and is rated at 2175 brake horsepower at its best efficiency. According to figures from an efficiency test made during the early part of this year on one of the units,* the flow at full gate, corresponding to a capacity of 2266 hp., was 362 cu. ft. per sec., and at 0.9 gate, 2150 hp., 306 cu. ft. per sec. This source also states that at 0.1 gate the efficiency of the turbine is 38.8 per cent, at 0.6 gate 90, at 0.9, 93 per cent and at full gate 91.6 per cent. The efficiency was a maximum at 2150 hp. corresponding to 0.9 gate. The rating is then at about 0.9 gate which means that it has but little overload capacity. The effective head which is 63 ft. at zero gate falls to 62.69 ft. at 0.1 gate and to 60.05 of full gate, due partly to the lowering of the water in the fore bay and partly to increasing friction in the penstock and draft tube.

On the floor above, direct connected to the turbine shaft is the generator unit shown in the sectional elevation of the plant and also in Fig. 6 which is a general view of the generator room which shows, in addition to the generators, an induction motor-generator set, which in emergencies is used to excite the main generators; the turbine governors; and a rear view of a portion of the switchboard. It will be noticed here that there are two main generating units of equal capacity. The output from these machines amounts to 3750 kv.a. which con-

*From a thesis on An Efficiency Test of the Allis-Chalmers Vertical Hydraulic Turbine at the Gregg's Falls Station of the Manchester Traction, Light & Power Co. presented by W. K. Ramsey, R. A. Snow, M. K. Winchester, and F. M. Powell to the Massachusetts Institute of Technology for the degree of Bachelor of Science in Mechanical Engineering.

stitutes the total capacity of the plant, i. e., the new plant. The old plant, however, is still in operating condition and is able to increase this figure by 2000 kv.a.

Figure 4 shows a closer view of one of the generators, and, through an opening in the floor, its turbine. As is the case with most high voltage generators of modern design, this generator is of the revolving field type. The framing around the stator armature is left partially open to facilitate the movement of air over the coils of both the armature and field. The rotor is fitted with air scoops or fan blades which maintain a continuous flow through these members and which serve to keep down the temperature.

Across the frame of the machine there is a heavy cast-iron span or bridge in which is fitted a Kingsbury thrust bearing which supports all the unbalanced weight of the turbine wheel, the shaft, and the rotors of both generator and exciter, which comprise all the rotating parts.

Operating under a pressure of 2300 v., this machine generates 3 phase, 60 cycle current, 471 amp. per phase or 1875 kv.a. at rated load. Inasmuch as the power factor on the system is normally about 80 per cent, the actual load on each machine is something in the neighborhood of 1500 kw.

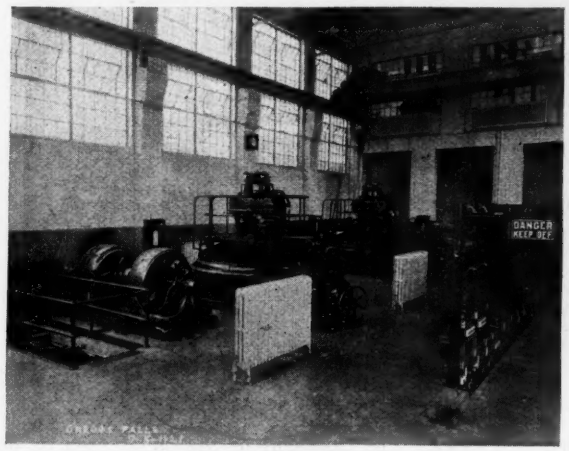


FIG. 6. GENERAL VIEW OF THE GENERATOR BAY

The exciter unit is mounted above the generator on a pedestal which is supported by the same bridge which carries the thrust bearing and is direct connected to the main shaft. Leads are taken from the direct-current commutator first to the switchboard and then back to the field slip rings, above, thus it is possible to excite the main generator field from an independent external source should it become necessary, for any reason, to do so. This unit develops 560 amp. at 125 v. and is rated, therefore, at 70 kw. As each exciter is designed to excite two generators, this amounts to a little more than 2¼ per cent of the output of the machine.

Belt driven from a lay shaft in the turbine room, which is driven through bevel gears from the main turbine shaft, is the governor, shown in Fig. 5, the purpose of which is to regulate the gates of the turbine in such a fashion that a constant speed is maintained regardless of what the load may be.

The dome at the top of the stand contains a governor head of the flyball type which controls the movement of a hydraulically operated piston in the regulating cylinder at the left, which piston turns the regulating shaft projecting below the governor stand. This shaft is connected with the gate-moving mechanism of the turbine: a 45-deg. rotation of the shaft serving to move the gates from completely open to the closed position.

In operation, if the turbine speed deviates as much as a quarter of one per cent from normal, the governor readjusts the gates. The operation requires about 2 sec. for the maximum gate movement; for fractional gate closures this interval is less. If required, the piston can exert a thrust of nine tons to force the movement. By means of the small handwheel at the top of the governor, the turbine speed may be changed from zero to normal and the governor will maintain whatever speed

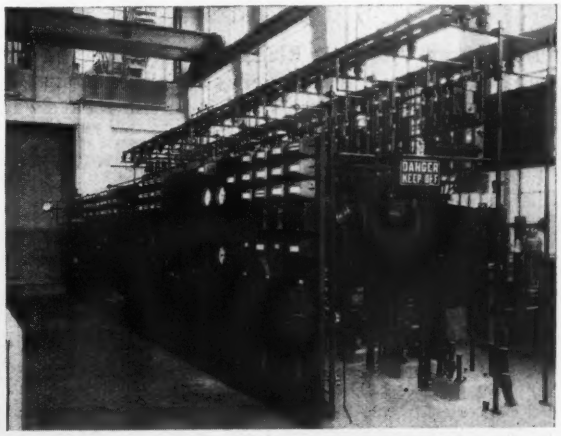


FIG. 7. CONTROL BOARD AND LOW-TENSION BUSSES

is established. In addition a small electric motor drive is provided which will turn the handwheel; the control wires for the motor run to the switchboard. By this scheme the speed of the turbine can be adjusted by the operator as he does his switching. This device is provided more especially for use in synchronizing alternators and is called a synchronizing attachment. The large handwheel at the side is part of a mechanism by which the regulating shaft and turbine gates can be actuated by the turning of the wheel. This form of speed control is used in emergencies when for some cause the automatic governor is not in operation.

The hydraulic piston is operated by oil under pressure which is maintained by a small gear pump which is driven from the main shaft of the turbine. This pump draws oil from the receiving tank and forces it into the pressure tank, which is of steel, 18 in. in diameter and 6½ ft. high. Oil fills the lower and air the upper portion of the tank. Since oil is incompressible, it would of course be impossible to maintain pressure in the tank without the air pocket. From the pressure tank the oil is admitted to the regulating cylinder as required, from which it afterward drains into the receiving tank, and is used over and over again.

Along the wall of the building on the generator room floor, are located the switchboard, generator busses, oil circuit breakers, solenoid switches, etc., shown in Figs. 6 and 7. All heavy current apparatus is fenced off in the rear. Except for switching equipment for the exciter system, the board contains nothing but recording

and indicating instruments; such as ammeters, voltmeters, kilowatt meters, frequency and power factor meters; voltage regulators and the push button switches and signal lights of the control system, where only a small current is used.

On this same floor, toward the river, is the transformer room of the substation. Here the pressure is raised from 2300 to 33,000 v. The transformers are connected delta-delta.

Directly above, in the high tension room, are the single-pole disconnect switches and high tension oil switches. The lightning arresters are on the roof above the switch room. From here the high tension leads are taken to the transmission towers on the roof. There are two circuits each capable of carrying the load of both generators.

Kelley's Falls

Down the "Squog" River about 5 mi. from the Gregg's Falls plant is the Kelley's Falls combination steam and hydraulic plant. The fall here is about 24 ft. and the power developed is rather small. At present the turbine installation is more or less antiquated and obsolete, but it is still in use and is delivering its quota of kilowatts to the system. This unit has a low efficiency, however, as compared with modern practice, and as the demand is already in excess of the available generator capacity a new installation is contemplated.

Adjoining this station is the steam plant of 7500 kv.a. capacity. Other steam reserve is located at Nashua and at Brook St. in Manchester.

Figure 8 shows an exterior view of the station from across the coal yard. To the right may be seen the substation and between these two buildings, the old hydraulic plant. The new building is of brick and concrete construction. It has its foundation on the flood plane of the "Squog" River and its roof is just about on a level with the surrounding country.

Going "from coal pile to switchboard" we start with the coal as it is brought in. Pennsylvania bituminous and semi-bituminous run of mine is delivered, in drop bottom cars, run out on trestle over the coal yard and dumped. Here a tractor crane picks it up in a grab bucket and piles it in the yard wherever there is space available. From this storage pile another similar crane passes it back to a small dump car, on this same trestle, which is moved along to a position over a bin where it is dumped. By this method of handling the crane is worked from one end of the yard to the other and no one lot is kept in storage for an overly long period of time.

From this bin the coal passes through a double roll crusher, where the pieces are reduced to a uniform size, and onto a bucket elevator which lifts it to the lower end of a long sloping belt conveyor which carries it over a considerable intervening space to the upper portion of the plant, thence over the long coal bunker in the boiler room. A movable spilling apparatus can be located in any position over the bunker so as to fill any portion that may be low. On passing from this bunker, the coal is weighed in automatic weighing machines and spouted down through four spouts to the stoker hoppers of the four boilers.

Ash is received in a hopper beneath the end of the stoker, from which it is dropped into a truck and wheeled away. The basement of the boiler room is on the surface grade, so that it is an easy matter to dispose of the refuse. Trucks are wheeled in on tracks that run beneath the hopper under the two banks of boilers, loaded and then pushed out on a trestle over a section of lower ground and dumped. Two results are thus accomplished; the refuse is expediently disposed of and useful ground is built up.

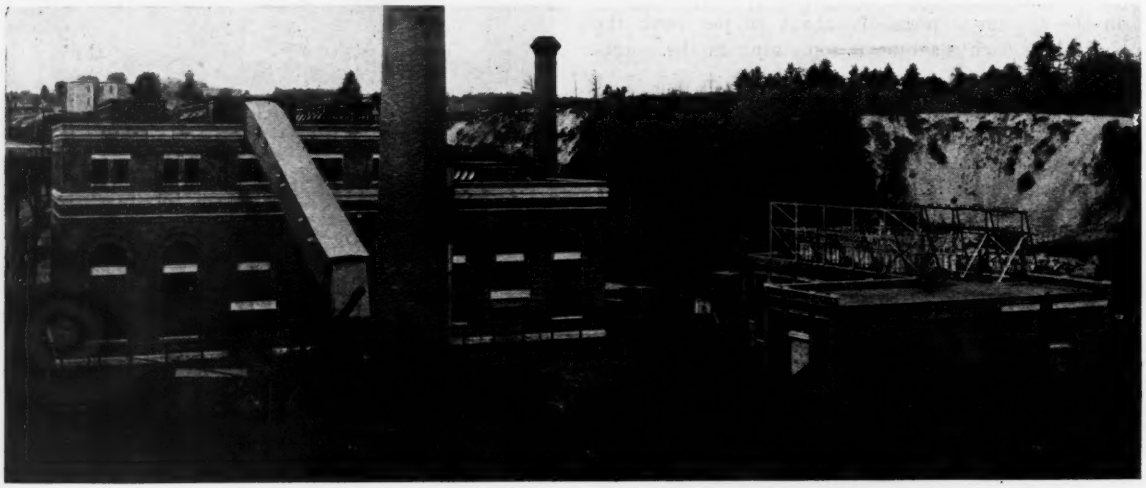


FIG. 8. KELLEY'S FALLS STEAM STANDBY STATION SHOWING COAL HANDLING APPARATUS

The boilers, shown in Figs. 9 and 10, on the second floor, are arranged in two groups of two, a set on either side of the firing aisle, Fig. 11, and there is room for a duplicate arrangement beyond the present layout. The plan of the boiler room, Fig. 9, shows only two boilers; the other two were installed at a later date. These boilers are each rated at 750 hp. but ordinarily they are made to carry 1500 boiler hp. or about 100 per cent overload. Under normal operating conditions they generate the equivalent of about 207,000 lb. of steam per hour from and at 212 deg. F., at 210 lb. pressure and 100 deg. superheat. Three safety valves, made by the Consolidated Safety Valve Co., on each boiler are set to blow at a pressure only slightly above the running pressure.

These boilers are of the horizontal water-tube type built by Babcock & Wilcox. Each contains 378 18-ft. by 4-in. tubes arranged in a bank 27 wide and 14 high, connected to three 3.5-ft. diameter shells. This bank is baffled by vertical baffles to form three passes. Above the tubes, between the first and second passes is a Foster superheater, connected internally to the steam space of the boiler shell.

The under-feed Taylor stoker used has eight retorts and is capable of handling three tons of coal per hr. The grate has an area of 13.5 sq. ft. per retort or 108 sq. ft. total. Two of the furnaces have a volume of 756 cu. ft. each and the other two, later additions, have 924 cu. ft.

The stoker shaft is chain driven from a lay shaft in the basement which is in turn driven by a multi-speed induction motor or by a vertical steam engine auxiliary.

The station operates under a semi-balanced draft system. A single chimney 225 ft. high and 11 ft. inside diameter at the top supplies the draft for the four furnaces and has capacity for four more.

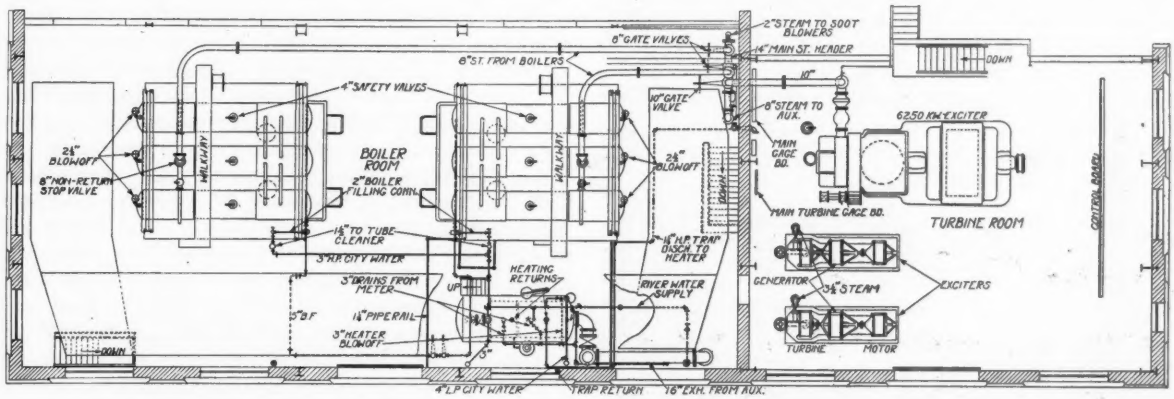


FIG. 9. PLAN OF THE BOILER AND GENERATOR ROOM FLOORS SHOWING LOCATION OF THE VARIOUS UNITS

Pressure is supplied under the grates by an American Blower Co. fan having a capacity of 48,000 cu. ft. per min. at 5.5 in. pressure, which is driven by 90 hp. vertical Troy engine. A standby blower of the Sirocco type having a capacity of 48,000 cu. ft. per min. at a pressure of 6 in. is direct connected to a 75-hp. Wagner motor. There is still another blower of the fan type supplied by the Green Fuel Economizer Co. which runs at 200 r.p.m. and is driven through reduction gearing by a 200-hp. Terry turbine running at 2500 r.p.m.

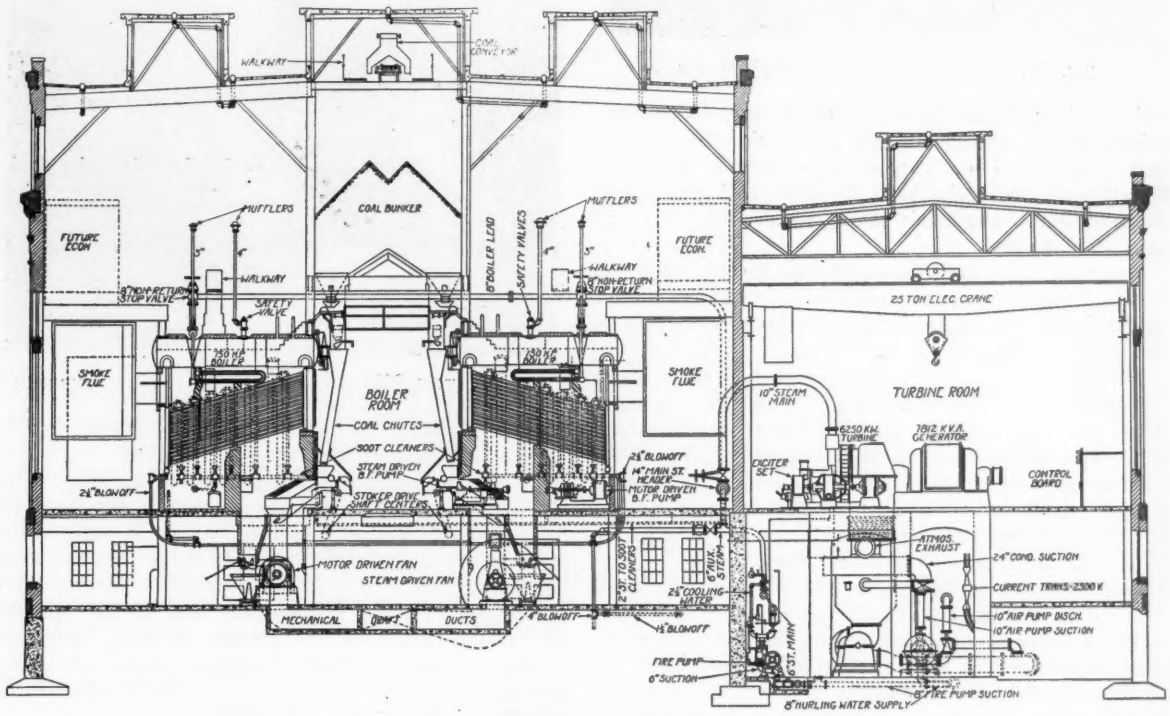


FIG. 10. LONGITUDINAL SECTION OF KELLEY'S FALLS PLANT

Either one of the smaller units is capable of handling the present load. The larger unit is installed to take care of future additions to the boiler capacity. With these blowers it is possible to maintain an approximately balanced condition at the grate.

Feed water is metered in a Hoppes "V" notch meter and then heated from an average initial temperature of 70 deg. to 212 deg. F. by the auxiliary exhaust, in a Hoppes closed type feed water heater, which has a capacity of 207,000 lb. per hr. Condenser returns are mixed with the necessary make up water from the river and pumped under pressure through the heater to the boiler by either one or two centrifugal boiler feed pumps or a direct acting steam pump.

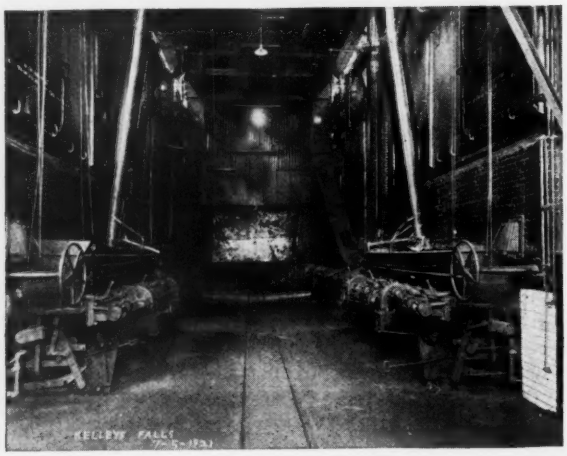


FIG. 11. FIRING AISLE AT KELLEY'S FALLS

The river water is composed almost entirely of melted snow and is exceedingly pure. Even in the raw state it has been found very suitable for make up water. No attempt has been made to treat this water and the condition of the boiler surfaces show that no treatment is necessary.

So pure, in fact, is the water that in making a test of the 1500-kw. unit at Gregg's Falls it was found impractical to provide a water rheostat large enough to absorb the power.

The first of the pumps mentioned is a three stage Jeanesville Iron Works centrifugal pump driven by a direct connected Alberger turbine; the second is a four stage pump of the same make driven by a 75-hp. Westinghouse induction motor. The capacity of this pump is 250 g.p.m. at a pressure of 225 lb. per sq. in. The Warren direct-acting steam pump has a capacity of 260 g.p.m. at 100 strokes per min.

A Worthington standby, two stage pump having a capacity of 500 g.p.m. and driven by a 50-hp. Westinghouse motor is connected in with the fire service system and is used, of course, only in emergencies.

An Anderson trap receives the drains from the various steam pipe lines and returns them directly to the boiler.

Except in a few cases the valves used throughout the plant in both the steam and water lines are furnished by the Walworth Mfg. Co.

All boilers are provided with Vulcan Soot blowers which are used at regular stated intervals. The tubes are therefore kept clean and the maximum amount of heat liberated by the fuel is transmitted to the water, with the result that the flue gases leave the breeching at a comparatively low temperature. A careful check is kept on the flue gas composition by means of a Uehling CO_2 recorder.

The plant is, at present, not equipped with economizers but provision is made for them and it is expected that they will be installed when the station is enlarged.

Steam is taken from these boilers in well insulated 8-in. lines to a short header from which there is a 10-in. line to the main turbine. The generator room is located back of the boilers, toward the river on the same level as the boiler room floor. Here current is generated at 2300 v. pressure, three-phase, 60-cycle by a General Electric generator, rated at 7812 kv.a., or at 80 per cent power factor, which usually obtains on the system, 6250 kw. The generator is driven by a direct connected, horizontal, nine stage, Curtis turbine which runs at 1800 r.p.m. and is also rated at 6250 kw. A view of the unit is shown in Fig. 12.

Through a port 5½ ft. in diameter the turbine exhausts directly into an Alberger jet condenser where a 28-in. vacuum is maintained. Circulating water which is taken from the river above the dam is removed by an Alberger removal pump, having a capacity of 11,300

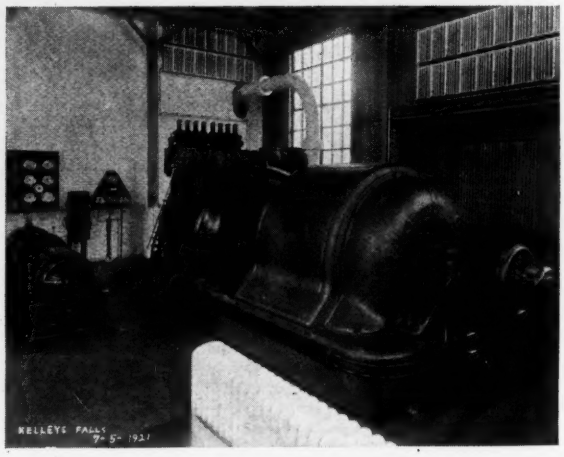


FIG. 12. THE 6250-KW. GENERATOR AND ITS TURBINE

g.p.m. against a 35-ft. head, direct connected to a 187-hp. Alberger turbine, shown in Fig. 13.

It may be noted in passing that during the summer months this pump discharges below the dam and the head pumped against is reduced by an amount nearly equal to the height of the dam. In the winter the warm circulating water is discharged into the forebay at a point just ahead of the flashing and on the opposite side of the river from the intake. There is, therefore, a flow of warm water established across the river through the dam which has been found effective in keeping ice from the flash boards.

Any portion of the warm water from the condenser may be discharged at a point where the intake for the condenser is located, so as to prevent the trouble due to anchor ice during cold weather. This has proved of great value in preventing shut-downs of the condenser during the anchor ice periods.

Air is removed from the condenser by an Alberger

85-hp. turbine driven air removal pump which has a capacity under operating conditions, with 1 in. of mercury absolute pressure, of the equivalent of 14 cu. ft. of free air per min.

The generator is cooled by a Spray Engineering Co. air cooling and washing system. Air is drawn through a fine water spray or mist where it is cooled and relieved of any dust that it might contain, and then through a series of baffles where any entrained water is taken out. It is then forced through the windings of the revolving field of the generator to waste.

Excitation current is supplied by either one or two duplicate exciter units. In both units the 100-kw. General Electric generator is direct connected to a 150-hp. G. E. induction motor on one end and to a Terry turbine of like capacity on the other. The question of which source of power should be used is determined by the heat balance of the plant. When the make up water is cold, as during the winter months, the turbine is used to supply enough additional exhaust steam to keep the feed temperature as near 212 deg. as possible. Otherwise the motor drive is used.

The three leads from the generator connected with three generator busses on a small G. E. control board on the west wall where the current is directed to a set of transformers which step up the tension to 33,000 v. At this pressure it passes through the high tension room similar to the one at Gregg's Falls and thence into the high tension transmission lines.

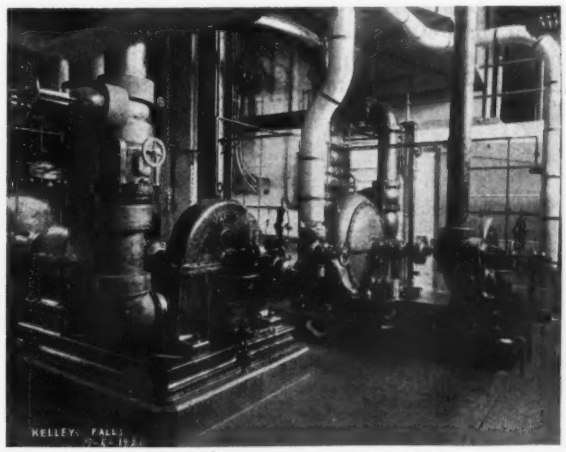


FIG. 13. CONDENSER REMOVAL AND VACUUM PUMPS

Centrifugal Pump in Sugar Refinery

EXPERIENCES WHICH HAVE LED TO SPECIAL DESIGNS. BY CLAUDE C. BROWN

IN SUGAR refining work the motor-driven centrifugal pump is rapidly growing in favor. There are a number of reasons for this. In the first place the motor-driven unit is compact, comparatively light in weight, takes up little floor space and is flexible in use. Then, the centrifugal pump is easily accessible and easily dismantled; it is a simple matter to take it entirely down, disconnect and replace the motor, shaft, runner or any other part in a few minutes.

Another reason why the centrifugal unit is gaining favor is the feature of safety. The centrifugal pump is practically foolproof. If the discharge valve were suddenly closed, nothing more serious would happen than the churning of the pump.

The adoption of the centrifugal pump in the sugar industry, however, has not been an unqualified acceptance of the pump used for general purposes. It has been rather a development or remodeling of the mechanism to fit sugar house needs and conditions.

In a western sugar refinery plant, great quantities of salt water are used for condensing purposes in connection with the boiling of sugar in vacuum pans. The pumps that handle this water are situated on the ground floor of the plant where they have a suction lift from the bay of from 12 to 15 ft. according to the tide, and a lift of approximately 150 ft. to the pan condensers.

These four pumps have 14 in. suction and discharge connections and have a capacity of 3500 g.p.m., they operate at 1200 r.p.m. and were installed to replace reciprocating steam units. From the very first, trouble developed in a number of ways. It was difficult to hold the suction at low tide. Upon investigation it was discovered that, due to the fact that there existed air pockets or leaks in the suction lines, air was finding its way into the pump suction. The introduction of this air was detrimental for several reasons: It many times caused the pump to lose its suction entirely; at other times it produced excessive vibration in pump and line, this vibration becoming so violent as to endanger the entire apparatus.

After much experimenting the introduction of air was eliminated by tightening all leaks in the suction line,

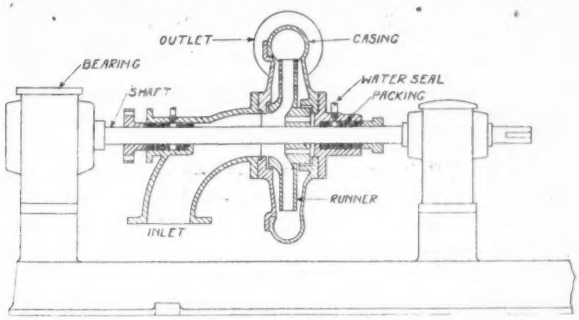


FIG. 1. SINGLE SUCTION CENTRIFUGAL PUMP WITH WATER SEALED PACKING

smoothing it out and eliminating air pockets and sharp turns. Long radius fittings were installed in place of the short radius type and all non-standard fittings removed.

One more thing was then done to complete the arrangement of perfect suction. At the points in the casing adjacent to the runner hub were shoulders in the casing casting which still continued to act as air pockets. The effect of these shoulders was overcome by venting them to the outer casing with a ¼-in. line.

This effectually destroyed any detrimental effect they might have had.

The method finally used to prime these pumps is unique. Formerly, a tank of salt water at an elevation of some 40 ft. above the pumps was kept full and lines connected it with the suction of each pump. Then when it was desired to start a pump, the foot valve

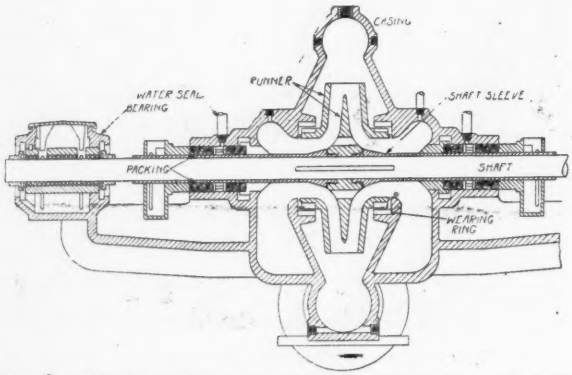


FIG. 2. DOUBLE SUCTION PUMP WITH PROTECTING SLEEVE ON SHAFT

being closed, the water from this tank was turned into the suction until it filled up to the pump and then the pump started up in the usual manner; however, in order to eliminate the necessity for this method of priming, a small vacuum pump was installed near the battery of pumps and a half-inch line run to each pump. At such time as it is desired to start one of the centrifugal pumps the small vacuum pump is started up

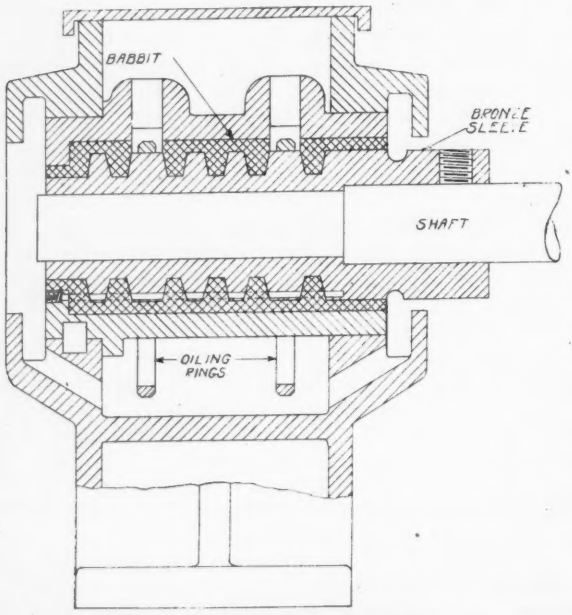


FIG. 3. MARINE THRUST BEARING

and any number of salt water pumps can be primed immediately.

The salt water pumps as first installed consisted of cast-iron casings with bronze and cast-iron runners. The shafts were of Cumberland steel. Before very long a vicious corrosion set in which was rapidly destroying both casing and runner. The cast-iron casing and bronze runner combination was discontinued and bronze casings were placed with bronze runners, the cast-iron casings being used in conjunction with chrome steel runners. The Cumberland steel shafts, having broken in several instances, were replaced with shafts of 3 per cent rough rolled nickel steel. In order to protect the shafts from the corrosive action of the salt water, bronze sleeves were shrunk on over the portions of the shaft that were inside the pump. The above combinations have worked out admirably for salt water and are giving no further trouble.

For the pumping of liquors, syrups, etc., other problems were met. Here again came the question of corrosion and erosion. Many combinations of pump casings and runners were tried with varying degrees of success, the most successful results being obtained with combinations of bronze casing, bronze runner, steel shaft with bronze bushings. This combination, while resistive to corrosion, was subject in many cases to severe erosion, the runner and casing taking the appearance of sand after water had run over it, the erosion

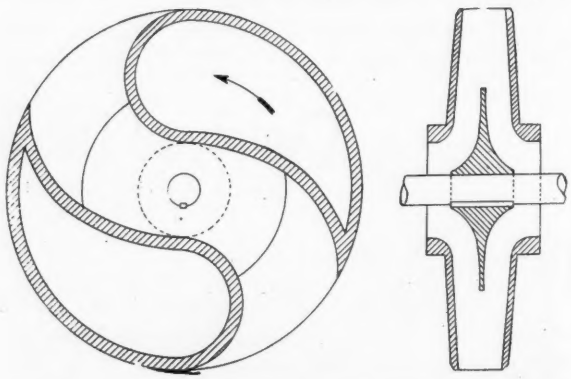


FIG. 4. SEWAGE TYPE RUNNER WITH DOUBLE SUCTION

producing a rippled effect. In locations and for services where this was noticed, a different combination was used, namely, cast-iron casing, chrome vanadium steel runner and monel metal shaft. The latter combination has worked out nicely and is giving good satisfaction.

In the pumping of sugar solution, it is absolutely necessary that the sugar solution does not come in contact with the pump packing. Should such contact be made, the sugar quickly cuts packing and shaft, and under such conditions a pump will rarely last for 24 hr. In order to prevent this and also to seal the pump against air leaks at the suction, a water seal is used. A quarter-inch line of fresh water is connected within each packing gland and just enough water allowed to enter the gland to seal it and prevent the sugar from coming out.

The question of type of pump runner has been given much attention. Originally all centrifugal pumps were furnished with the multiport runners, the diameter and width of the runner determining the lift and capacity of the pump. The most successful type of runner yet developed for general all-round requirements is the sewage type runner, consisting of just two parts. This type has given good satisfaction and has held up well. The open type runner, which resembles an open star, has also proved successful. This type is useful for pumping liquids which have matter in suspension.

Refinements of Practice in Modern Power Plants

POINTERS ON BREECHING DAMPERS, TURBINE OPERATION AND CARE OF BOILERS. BY I. L. KENTISH-RANKIN

THE STACK or breeching damper is to the furnace what the throttle is to the automobile. Yet many boiler rooms lack dampers or they are in such dilapidated condition as to be practically worthless. A damper will be used only when its control mechanism is accessible.

Although often only one main stack damper is installed, a breeching damper for each boiler is always desirable. Only in this way can each boiler be operated according to its individuality and special peculiarities and ever-changing conditions of fuel bed and draft. This is true regardless of whether mechanical or natural draft or hand or mechanical firing are employed. As, theoretically, each boiler damper requires adjustment for every different condition of the fire and rate of evaporation, it follows that the more easily a damper can be manipulated the more likely it is to be changed frequently and according to the need. In practice, the damper is generally set for an average condition and changed only when there is a radical modification in operating conditions; and the amount of excess air varies with the demand for steam. Obviously this is very wasteful of fuel. This is one reason why automatic damper control always shows a big fuel saving as well as closer steam pressure regulation.

The more easily a damper can be manipulated the more likely is it that it will be manipulated. Therefore the damper mechanism should be located near the draft gage, and steam-flow meter, so that the fireman can see when the damper requires closing or opening and can do it without needless effort and without walking from one place to another. Draft gage and damper control should be located together; each is the complement of the other. It is an interesting fact worth noting that almost all the recent large installations of boiler-room instruments have been made beside the damper and stoker controls instead of being far removed from them as was the case a few years ago.

The position of the damper should be known either by an indicator or calibrated device so that the fireman can quickly set the damper for any set of conditions. A draft gage is, of course, indispensable to proper draft control; a gage giving draft under and over the fire suffices instead of a calibrated damper, though both are desirable. Proper damper position is an important factor in determining the coal consumed by banked fires; it is second in importance only to the position of the ash pit door and the thickness and condition of the fuel bed.

Absence of a breeching damper is often overcome by manipulation of the ash pit door. Closing the ash pit door instead of closing a damper in the stack reduces air flow through the fire but increases the air infiltration through cracks. It tends to promote overheating of the grate bars because the cooling effect of in-rushing air is stopped; with coals high in sulphur there is also greater opportunity for corrosion and the formation of clinker and slag, as the sulphur is melted and runs down between the overheated grate bars instead of being burned. In no case should the ash pit damper be used instead of a breechings damper; their purposes are different.

Air flows along the path of least resistance. Excessive opening of breeching dampers near the stack is often the cause of needlessly high combustion rates of the boilers nearer the stack while difficulty is experienced in maintaining combustion rates in the furnaces farther removed from the stack. This is because the air flows through the furnaces closest to the stack, short-circuiting those farther away. This condition is particularly likely to make itself felt at the time of year when natural draft is used. The dampers of furnaces closest to the stack should be closed down when the fires are not active.

Dampers should be protected so that they cannot, of themselves, close. A reversed draft such as may occasionally occur will close a damper, bring combustion to a sudden halt, melt down the brickwork and work havoc with the stokers unless quickly opened again. Periodic inspection of dampers is necessary to maintain them in proper working condition, overcome warping and combat corrosion, to which all dampers are subjected.

The inconspicuous damper usually receives less attention than it deserves; and economy and flexibility of operation suffer as a consequence.

STARTING TURBINES

THE ENGINEER who is accustomed to the reciprocating engine and has never operated a turbine cannot help feeling nervous when first called upon to take charge of a turbine plant. In reasoning things out, he often encounters two opposing theories, each of which sounds plausible, but only one of which is right. A mistake may be costly.

One such example is when starting a turbine from the cold. So much has been said about distortion that there is good excuse for feeling nervous about it. Yet there is no excuse for distortion in starting a turbine from the cold if the reasons for distortion and how to prevent it are understood. Distortion will not occur so long as rotor and casing are heated uniformly; it is the uneven heating that causes the rotor to spring or the casing to warp. Yet many engineers start their turbines in a manner that is ideal for distorting them.

That heating may be uniform it follows that the distribution of steam should be fairly uniform throughout the interior. There is no better way of distributing steam thoroughly and intimately throughout the interior than to have the rotor turning. Therefore the best way to prevent a turbine from being distorted is to start the rotor turning and keep it turning until the rotor and the case are uniformly up to temperature. Before starting up, all drains should be opened and steam turned on a little for three to five seconds to clear the drains of entrained water. Then give the turbine a good shot of steam, sufficient to start the rotor turning over, by opening the throttle quickly and closing it again as quickly, once the rotor is moving. Then the steam should be turned on again, but only sufficiently to keep the rotor slowly turning.

Starting in this way causes the steam to be circulated throughout all blades and all over the casing by the action of the rotating rotor. There is no likelihood of uneven heating and less steam is required than when heating with the rotor stationary. The drains should be kept open during the warming up process, unless the machine is started up under vacuum, in which case the drains should be piped into the vacuum space through a trap.

The "go easy" method of starting a cold turbine, while apparently a cautious method, is really dangerous since it encourages distortion. Many engineers follow this method, especially when first taking charge of turbines. This method consists of opening the throttle very slightly so that only a small amount of steam flows into the turbine. As the steam flows along the top and as the rotor is stationary, uneven heating occurs and distortion may develop. Not only is there the liability of distortion, but it takes longer and uses more steam to warm up a turbine this way than the former way, which is recommended.

It is well to bear in mind that severe damage may be done a turbine by distortion due to improper and undue haste in starting from the cold. It takes a long time for a hot turbine to cool off; it takes a long time for it to become hot, also. It is not the temperature attained but the degree of uniformity that is so important; 10 to 15 min. rotation at minimum speed suffices with small turbines, while 30 min. is desirable for large machines. Starting from cold in haste, except, perhaps, under the most extreme emergency, is not a sign of good operation but is foolhardy.

Laying Up Boilers

There are a good many boilers laid up at this time because of curtailed industrialism. A boiler may deteriorate much faster when laid up than when kept in active service unless due precaution is taken. A boiler insurance inspector told me recently that in far too many cases boilers are laid up carelessly and without any apparent effort to safeguard them against corrosion. Rust, corrosion and chemical action are, of course, the conditions to be combated.

How a boiler should be laid up depends upon how long it is to remain inactive. If the period is for a few weeks the boiler may be filled with water; otherwise it should be emptied, dried and cleaned scrupulously. Before filling with water, the boiler should be emptied and the entire metal inside and outside thoroughly cleaned (this is often done carelessly) so that scale and sludge on the inside and soot and flue-gas dust on the outside are removed. Pure, clean water should then be used to fill the boiler, adding soda ash to make the water strongly alkaline. A fire should then be started gently and maintained sufficiently to drive out air entrained in the water and pockets of the boiler. The fire should then be drawn and the boiler filled with water to the limit; this prevents serious breathing. The furnace should then be cleaned and all ash, soot and other corrosive and hygroscopic matter removed; and the furnace doors left open so as to assure ample circulation of air through the furnace and gas passages of the boiler.

When a boiler is to be laid up "dry," dryness and cleanliness are the two important conditions to be met. Empty out the water, wash out thoroughly and then mop to assure the removal of moisture. The furnace should be cleaned out, also the flues. Special care should be taken to remove soot, as it holds and absorbs moisture and is highly corrosive. Tubes should be rubbed down and cleaned for the same reason. A frequent cause of trouble is that steam, condensation and feed water enter a laid-up unit; frequent inspection should be made to ascertain if valves are tight.

Many engineers strive to prevent the entry of air in the boiler while others endeavor to keep up a good circulation. A good current of air through the flues tends to prevent the accumulation of moisture, providing the air is dry. A practice that many engineers advocate is that of placing trays of lime in the boiler drums so as to absorb whatever moisture may enter. Furnace grates may also be covered over, lime spread on and the doors closed although the consensus of opinion seems to favor leaving the doors open on the theory that ample ventilation is beneficial.

The fact to bear in mind when laying up boilers is that cleanliness is of first importance. Submerged metallic surfaces do not corrode like moist surfaces or surfaces in contact with contaminated air. If properly prepared a boiler when laid up will not corrode. If improperly prepared the corrosion will, on the other hand, be more rapid than when the boiler is in active service. The important thing is to do a good job and keep a close watch for leaks and other conditions that tend to cause corrosion.

Observations on Coal Hoppers

During the hot spell last summer the writer visited a large steam plant having about 50 boilers. This plant was burning low grade Illinois coal. One coal hopper serves six boilers; each hopper was cement lined, and has a capacity of about 2000 t. of coal.

Because of the low grade coal, the fact that the weather was hot and the boiler room hotter and that the coal had been transported direct from mine to hopper, the coal caught fire in the hoppers. The coal was dumped in the hoppers by crane, one man working in extremely cramped quarters. When the coal caught fire the heat and smoke given off by the burning coal prevented digging it out and playing water into the hopper had apparently no effect.

As the coal burned it coked and caked together, choking the stoker spouts, introducing difficulties with the stokers (of the underfeed type) and resulting in loss of steaming capacity because of the condition of the fuel when it reached the fuel bed. A smoky and hot boiler room did not tend to improve matters. The situation was solved only when the coal had burned itself out and the hopper had been emptied and cleaned while the furnaces were supplied with coal by hand. The incident proved very costly in every way; as well as seriously crippling service.

This incident has a moral. The coal hopper that extends the entire length of an aisle and serves half a dozen or several boilers instead of one costs less than individual hoppers and the coal handling problem is somewhat simplified. A greater tonnage can be stored in a given boiler-room space. But the disadvantages seem to outweigh the lower initial cost of the single hopper.

One hopper per boiler segregates fires in the coal and makes them less likely to occur because of the smaller

amount of coal involved. The use of different coals is simplified and made safer. Boiler tests and data on coal consumption are more conveniently obtained where the coal is weighed as it comes to the station. Where a run of bad coal is received, the individual hoppers make it possible to segregate this. Where space or cost necessitates using one hopper for several boilers, and a coal susceptible to spontaneous combustion is to be used, it would seem that walls or partitions would be advisable so as to segregate the coal in storage and so lessen the chance of a fire to spread. These partitions would not, however, be of much use in preventing the transmission of heat from adjacent sections. The question of providing greater space and more accessibility in case of emergency above coal hoppers is also worthy of consideration in many plants.

Comparing Central Station Economies

Getting Down to a Common Basis. By George C. Cook

IN CENTRAL station operation, there are two principal objects to be attained; namely, continuity of service and high economy, of the two continuity of service being, of course, paramount. Records of economical operation have been made for stations of various types and sizes and under different working conditions, which serve as a goal to be reached or if possible passed; however, the development of central station equipment has been of such a rapid character, that records which have been considered the maximum possible at the time made, have soon been surpassed due to the introduction of more modern and efficient apparatus.

Valuable information with regard to the efficiency of design and operation of a station may be made by comparing its operating records with those of other stations, care being taken to make due allowance for all modifying factors. Equally if not more valuable are comparisons made with the past records of the station itself, the aim being to show a constant improvement; any falling behind in economy should be at once noted and the reason for this decline discovered and remedied if possible.

Common Basis for Comparison

In making such comparisons, it is necessary to reduce the economy results to a common basis. There are five items which may be used to express station performance; namely, total cost of generation per kilowatt-hour (including fixed charges), total operating costs per kilowatt-hour, units of fuel per kilowatt-hour, B.t.u. per kilowatt-hour, and the thermal efficiency. The first item could not be used as a direct criterion of success in design or operation although it is influenced by both. This item is the sum of the fixed charges and the operating costs, both of which are influenced by factors other than design and operation; for example, fixed charges are dependent upon the initial cost of the installation, cost of money and taxes and skill in financing; operating costs depend upon the cost of fuel and labor.

The second item, operating costs, is as stated above, dependent upon the cost of fuel and labor and therefore not a suitable basis for comparisons with respect to efficiency of design or operation. The third item, units of fuel per kilowatt-hour, is a true basis of comparison provided the same fuel with the same heating value and other characteristics is used in each case.

The fourth and fifth items are the most satisfactory units to use from an engineering standpoint since they truly represent the ability of the plant to convert the potential energy of the fuel into electrical energy at the switchboard and are independent of the heating value of the fuel. The fourth and fifth items are virtually the same, the thermal efficiency being the B.t.u. equivalent of the kilowatt-hour (3410) divided by the B.t.u. used per kilowatt-hour. The fourth item, B.t.u. per kilowatt-hour is the most commonly used in central station practice.

In making comparisons between the economy of different stations to determine the relative operating efficiency we must not neglect to discount such modifying factors as, difference in station design; size and character of equipment; kind and characteristics of fuel; load characteristics as indicated by the load factor; quantity and temperature of condensing water and character of the boiler feed water. The above-named factors limit the economy which it is possible to obtain with any particular station, but how closely this limit is approached is dependent upon the efficiency of operation.

The station design is, of course, a compromise dictated by the desire to obtain the highest commercial economy rather than the highest limit of thermal efficiency; thus due to the design, one station may be able to carry its boilers loaded at a more efficient point or have a more advantageous loading of its turbines than another. Again the necessity of maintaining a higher standard for continuity of service may make necessary greater reserve capacity and possibly less efficient loading than in a case where short interruptions are not of such moment. The size and character of the equipment is important, the larger units in general being more efficient. Consideration should be given as to whether the station is equipped with economizers and superheaters, the furnace design and volume, character of fuel-burning equipment and character of condensing apparatus.

The kind and characteristics of the fuel used has a most important bearing on the economy which can be obtained. Fuels which are high in moisture such as lignites, or high in hydrogen, as for instance, natural gas, cannot theoretically give as high combined boiler and furnace efficiencies as those with lower moisture or hydrogen content. Further, it is possible to obtain higher boiler room efficiency over an extended period of time with oil than with coal due to the fact that the standby losses are less; even though with the proper equipment and furnace design in each case equally good efficiencies may be obtained on test with either high grade Eastern coals or oil.

Influence of Load Factor

A factor of great influence on the economy is the character of the load. The characteristics of the load

are shown by the load factor; a load factor of unity, representing a uniform load; load factors of less than unity representing variable loads. The lower the load factor, the higher, relatively, the peak loads which have to be carried. The greater the variations in the load, the greater will be the standby losses and the more difficult it will be to proportion the various units to meet this condition and at the same time keep them running at or near their point of maximum efficiency.

In examining station performance to determine the limitations imposed by the design, records obtained over a test period where particular care is taken to eliminate inefficiency in operation, will be found most valuable. A heat balance of the station is of inestimable value in showing what losses occur and whether they are due to faulty operation or design and whether they are remediable or otherwise.

Keeping Records

Care should be taken to see that the logs of the plant are kept in a systematic and accurate manner. A daily log of the various observations should be kept by the watch engineers and from this a daily report prepared showing the principal data and economic results; it is desirable that this report should be sufficiently detailed to serve as a basis for the calculation of a heat balance. Instruments should be provided for obtaining all necessary data but it should be remembered that this is only the first step towards getting accurate records and unless they are regularly and systematically checked their indications will be misleading.

A great deal of discrimination should be used in accepting published records of station performance; usually they are incomplete and frequently inaccurate. Items such as energy purchased, steam sold, etc., are often not taken into account in such reports and it is well not to give too great weight to any report of station performance unless it is well authenticated and the full details known.

Relative Efficiency of Condensing Apparatus*

Results of Comparative Tests Carried Out on Double-Pipe Coils, Submerged Coils With and Without Manifolds, and Cooling Towers, and of Value as a Guide in the Selection and Design of the Most Efficient Type of Condenser. By Allen F. Brewer and Frank A. Stivers

IN ORDER to arrive at conclusions concerning heat transfer which would ultimately be of value as a guide in the selection and design of the most efficient type of condenser, certain experiments have been carried out by the authors on a number of the most general designs of such apparatus for the purpose of obtaining data indicative of the relative efficiency of each. On account of the difficulties in construction that would have arisen, as well as the variation in operation, had any vapor other than steam been used as a medium to be condensed, it was considered best to carry out all tests with low-pressure steam. It is quite evident that the relative ability of each type of condenser as far as heat transfer is concerned is the same whatever the vapor passing through it; therefore the authors have felt justified in having conducted their experiments using the most uniform vapor available, i.e., steam.

Types of Apparatus Tested

Four types of apparatus were tested, namely:

Double-Pipe Coil
Submerged Coil, Not Manifolded
Submerged Coil, Manifolded
Cooling Tower.

Descriptions of these immediately follow.

Double-Pipe Coil—Built of 2-in. pipe within 3-in. pipe. Length of 3-in. pipe between fittings, 18 ft. 2 in.; effective length of 2-in. pipe, 19 ft. 2 in.; overall length of coil, 20 ft. 2 in.; height, 6 ft. 3 in.; area of cooling surface, 146 sq. ft. Coil supported vertically between two sets of 3-in. pipe driven into the ground with holes drilled at proper intervals to support bolts for the coil pipes. Solid-end fittings manufactured by the York Manufacturing Co. for refrigeration purposes were used. Eleven sets of fittings in all with extra inlet and outlet fittings. Low-pressure steam used in all runs on this apparatus. Steam inlet at top of coil to pass between 2-in. and 3-in. pipes. Condensate outlet to bottom of coil and therefrom to tank and scale for weighing. Cooling-water inlet at bottom of coil within the 2-in. pipe. Outlet at top of coil, thence to ditch. All cooling water taken from hydrant line and metered.

Submerged Coil, Not Manifolded—Built of 30 lengths of 2-in. pipe, 8 ft. long, joined together with standard return bends. Arranged in a coil five pipes high and six pipes wide. Total area of cooling surface, approximately 162 sq. ft. No manifold fitted, therefore same steam particles entered at top and passed back and forth through all the pipes to leave the outlet at the bottom and flow to a tank and scale for weighing. Coil set in a steel tank 2 ft. 4 in. high, 3 ft. 9 in. wide and 10 ft. long. Seams of tank doped to prevent leakage. Cooling water taken from hydrant line via meter and 2-in. pipe to the bottom of the above-mentioned tank. Water overflow at top of tank via 3-in. pipe to ditch. As close to counterflow as possible in such an apparatus was thus obtained. Size of coil overall, 20 in. high by 24 in. wide.

Submerged Coil, Manifold Type—Built of 30 lengths of 2-in. pipe, 8 ft. long, manifolded at inlet and outlet into five sections of six pipes each. Intermediate connections of all piping were made with standard return bends. Total area of cooling surface was approximately 162 sq. ft. Live steam used due to lack of available exhaust steam. Steam inlet at top of coil via manifold. Controlled by a valve and gaged. Condensate outlet via bottom manifold and thence to a tank and scale for weighing. Coil set in a steel tank 3 ft. 2 in. high, 2 ft. 1 in. wide and 10 ft. long. Seams calked with asbestos packing to prevent leakage. Cooling water taken via hydrant line and meter and 2-in. pipe to the bottom of the tank. Water overflow at top of tank via 3-in. pipe to ditch. As close to counterflow as possible in such an apparatus was thus obtained. Overall size of coil, 23 by 23 in.

Cooling Tower—Built of 2-in. malleable iron pipe and standard fittings, three pipes wide, nine pipes high

*Abstract of paper presented at a meeting of the Houston Section of The American Society of Mechanical Engineers, Houston, Tex.

(i.e., three nine-pipe sections) with manifolded inlet and outlet. Overall lengths of pipes, 8 ft.[1] Distance center to center horizontally 19 in., vertically, 8 in. Approximate area of cooling surface, 146 sq. ft. (including horizontal pipes, vertical nipples, standard fittings and manifold fittings, etc.) Overall height of coil, 5 ft. 3 in., length 8 ft. 5 in., width 3 ft. 9 in.

Cooling-water distribution over the tops of the coils was carried out by means of a 2-in. inlet pipe, taking water from hydrant line via a meter and thence to a tin distributor box at the opposite end of the coil from where the steam entered. Flow of both steam and cooling water was parallel; i.e., from top to bottom. From the distributor box the cooling water was fed to the top pipes of the coil by means of wooden troughs, having a canvas strip in the apex of each. These troughs were easy to adjust to obtain equal and uniform flow over the coil, the water flowing over the top of each trough and dripping down the canvas strip on the top pipe and thence in sequence to the lower runs of pipe. It was attempted to obtain a certain amount of counterflow by installing a series of six garden-hose nozzles attached vertically to a ¾-in. piping fed by the main cooling-water supply and controlled by a valve. This proved, however, to have no material advantage and to be beyond proper control.

Wood baffling 4 in. on centers constructed to uprights at each corner of the coil was installed around the entire apparatus to do away with splash and still provide free access for the air. Exhaust steam of 5 in. pressure was used, being led to the coil via a top manifold and controlled by a valve. Condensate outlet was via a bottom manifold and thence to a barrel and scale for weighing. Steam was trapped and pipes covered to obtain as dry steam as possible. All cooling water used was taken from the hydrant and metered.

Method of Conducting Tests

Low-pressure steam of an average quality of 98 per cent was used throughout as the condensing medium. In every case, four variable factors presented themselves for consideration, namely:

Temperature of cooling water entering condenser
Quantity of cooling water
Temperature of condensate
Quantity of condensate.

There was as well a certain variation occurring in the heat content and temperature of the steam, but not of sufficient amount to influence materially the results obtained. Throughout the experiments, the temperature of the inlet cooling water was held as constant as possible, thus eliminating this variable from further consideration. Three separate series of tests were therefore carried out on each type of condenser, maintaining one of the three remaining variable constants in each case, namely:

1. Volume of condensate constant; temperature of condensate and volume of cooling water varied.
2. Temperature of condensate constant; volume of cooling water and volume of steam varied.
3. Volume of cooling water constant; temperature of condensate and volume of condensate varied.

[1] See Bureau of Mines Bulletin No. 176, page 36: "It is well when possible to place pipes in a continuous coil so that an air space not less than twice the diameter of the pipe will be left vertically between pipes of the same coil, and a space of 8 to 10 times the diameter of the pipe will be left open horizontally between sets of coils."

Results Obtained in the Tests

The results of the tests are given in the table. In every series the order of efficiency was practically the same, namely:

1. Double-Pipe Coil
2. Submerged Coil, Not Manifolded
3. Sumberged Coil, Manifolded
4. Cooling Tower.

The results cannot be assumed as indicative of the capacity of various condensers under practical conditions, inasmuch as in some cases it required as high as 40 lb. pressure to force the steam through the coils. The data are intended purely to show a comparison of efficiency and relative heat transfer.

A comparison of the manifolded and non-manifolded submerged coils indicates the same limitations. In fact, even though the efficiency of a non-manifolded coil is the higher, yet it may be necessary in practical operation to manifold the coil in order to provide adequate

DATA OBTAINED IN TESTS OF VARIOUS TYPES OF CONDENSERS

Length of test, min.	Temp. of inlet water, deg. F.	Temp. of outlet water, deg. F.	Steam pressure, lb. per sq. in.	Temp. of steam, deg. F.	Temp. of condensate, deg. F.	Cooling water per min. gal.	Condensate per min. lb.
CONSTANT FLOW OF CONDENSATE							
Double-Pipe Coil:							
60	86	210	5	228	95	5.0	8.3
60	86	209	5	228	91	6.1	8.5
60	90	207	5	227	89	6.5	8.2
60	90	206	5	226	88	7.9	8.5
60	87	202	5	228	88	9.5	8.4
60	86	193	5	223	87	10.8	8.6
60	86	178	5	225	86	12.8	8.4
Avg.	87.3	200.7	5	226.4	..	....	8.4
Submerged Coil, Not Manifold:							
40	92	139	4	226	96	29.4	8.4
40	94	146	4	226	96	23.8	8.3
40	94	141	5	227	97	20.7	9.3
40	94	158	5	227	98	16.3	8.9
40	95	168	5	227	99	13.2	8.5
40	94	172	5	227	102	8.9	8.3
40	94	181	5	227	106	5.0	8.7
Avg.	94	158	4.7	226.7	...	....	8.6
Submerged Coil, Manifolded:							
60	90	192	5	227	120	4.8	8.2
60	90	194	5	227	113	10.4	8.4
60	90	177	5	227	106	15.6	8.4
60	90	153	5	227	103	19.6	8.9
60	91	141	5	227	102	22.9	8.4
60	91	135	4	226	102	29.8	8.5
Avg.	90.3	165.3	4.8	226.8	...	....	8.5
Cooling Tower:							
60	92	110	5	223	108	23.7	8.8
60	92	111	5	222	110.5	21.9	8.0
60	92	112	5	224	111	20.9	8.2
60	92	113	5	224	112	18.8	8.3
60	92	115	5	224	113	16.8	8.5
60	92	120	5	219	118	12.9	8.7
60	92	127	5	220	119	11.9	8.8
Avg.	92	115.4	5	222.3	...	....	8.5
TEMPERATURE OF CONDENSATE CONSTANT							
Double-Pipe Coil:							
40	90	211	4	225	96	5.1	5.0
40	90	211	12	244	96	7.9	10.1
40	91	214	20	259	96	11.3	13.7
40	91	213	24	265	96	16.3	16.4
40	91	210	30	274	96	24.8	19.9
40	91	195	40	287	96	36.3	28.0
Avg.	90.6	...	..	...	96	....	....
Submerged Coil, Not Manifolded:							
60	95	148	5	228	97.5	10.5	2.9
90	90	172	5	229	92.0	9.7	4.3
60	93	142	5	227	95.5	13.3	5.3
60	94	149	5	228	94.5	17.3	7.9
90	91	161	5	229	94.0	19.5	8.9
60	94	148	5	229	95.5	24.0	10.0
90	92	155	5	224	98.0	28.8	12.4
90	95	139	5	222	103.0	47.0	13.1
Avg.	93	...	.	...	96.3	....	....
Submerged Coil, Manifolded:							
60	88	153	2	219	96	11.9	5.8
60	90	160	2	219	94	11.5	6.5
60	90	162	3	222	96	12.9	7.7
60	90	159	4	225	96	16.3	8.5
60	90	149	5	228	96	23.2	9.1
60	91	145	7	233	99	29.5	9.2
60	90	132	6	230	102	34.8	9.8
60	92	134	8	235	102	37.5	10.0
Avg.	90.1	...	.	...	97.6	....	....
Cooling Tower:							
60	92	106	5	228	110	13.2	4.1
60	92	106	5	228	110	13.9	5.9
60	92	116	5	228	110	16.8	7.0
90	92	100	5	225	100	18.8	8.0
40	92	104	4	225	105	25.8	8.4
40	92	106	4	225	105	33.3	8.7
40	92	106	4	225	105	47.2	8.9
Avg.	92	...	.	...	106.4	....	....

Length of test, min.	Temp. of inlet water, deg. F.	Temp. of outlet water, deg. F.	Steam pressure, lb. per sq. in.	Temp. of steam, deg. F.	Temp. of condensate, deg. F.	Cooling water per min. gal.	Condensate per min. lb.
COOLING-WATER FLOW CONSTANT							
Double-Pipe Coil:							
30	92	230	50	298	115	23.8	31.5
30	92	221	40	287	105	21.6	24.1
30	92	212	30	274	98	21.7	20.3
30	92	190	20	259	95	21.6	16.3
30	92	188	15	250	94	21.4	13.4
30	92	160	8	235	94	21.5	10.5
Avg.	92	...	..	...	...	21.9	....
Submerged Coil, Not Manifolded:							
60	96	120	5	224	96	21.2	2.4
60	96	141	5	224	97	21.1	5.6
60	94	156	5	227	98	21.6	8.8
60	93.5	166	5	224	99.5	20.9	10.8
60	92	172	5	224	100.5	20.7	12.6
60	92	172	5	223	105.0	21.7	14.1
40	91	192	18	255	110.0	20.0	14.8
40	92	192	20	259	122.0	20.2	16.2
40	91	200	22	262	137.0	21.4	19.3
Avg.	93	...	..	...	.....	21.0	....
Submerged Coil, Manifolded:							
60	88	122	¼	213	93	20.0	3.7
60	88	125	1	216	95	20.3	4.5
60	90	130	2	219	97	20.3	5.3
60	90	142	4	225	101	20.0	6.8
60	92	161	7	233	108	20.3	10.1
60	89	171	8	235	111	20.2	11.0
60	89	160	9	237	117	21.1	11.9
60	92	151	10	240	146	20.5	13.0
Avg.	89.8	...	....	...	...	20.3	....
Cooling Tower:							
90	94	94	5	225	86.7	17.7	1.7
90	93	99	5	226	94.8	19.3	3.6
60	93	94	5	226	90.0	19.0	3.0
90	88	98	5	227	96.0	14.2	5.7
90	89	100	5	227	108.0	14.4	8.2
60	92	122	5	224	120.0	18.3	10.5
60	92	125	5	225	125.0	20.4	12.1
90	93	118	5	218	131.5	18.1	15.6
Avg.	91.8	...	.	...	.....	17.7	....

area for flow; although this must be done at the expense of a decrease in heat transfer.

The double-pipe coil gives the nearest perfect counterflow of the mediums as is indicated by the high outlet-water temperature and low condensate temperature. In the submerged coil perfect counterflow cannot be gained, but a partial effect is obtained by putting the inlet water entrance at the bottom and at the opposite end of the coil from the steam inlet which is located at the top of the coil. The data show a cooler outlet water and warmer condensate than for the double-pipe coil. The handicapping feature of the cooling tower is that an unavoidable parallel flow of the medium exists; and a high temperature of condensate prevails.

The possibility of spraying the outside of the double-pipe coil is worthy of mention and consideration in the construction of a practical condenser. No actual data were taken to support this contention in the experiments in question, but it was noticed that a marked heat transfer by evaporation was clearly evident on several occasions when the apparatus was operating and showers occurred.

There is one advantage held by the cooling water which must not be overlooked, namely, the fact that evaporation is used for carrying away the major part of the heat, only a small amount being transferred as sensible heat to the cooling water. This is a practical advantage if the cooling water is to be spray-cooled and reused. The effect that weather conditions have on the coils is marked. When humidity is high, when there is rain or little breeze, evaporation will be decreased and vapor clouds hang heavily around the coils. Most efficient operation was found to occur when a light breeze prevailed and the air was dry.

In conclusion, the following points may be emphasized as being brought out by the data obtained in the tests:

1. On a basis of heat transfer the double-pipe coil is far superior to any of the other types of condensers tested; the degree of superiority and the comparative efficiencies of the others being shown clearly by the resultant curves.

2. Considering the submerged coils, the non-manifolded type of apparatus shows a better heat transfer than the manifolded coil under like operating conditions.

3. On a basis of low output temperature of the cooling water, the cooling tower is much superior to other coils, as the data indicate. This characteristic is of value if the cooling water is to be cooled and reused. —Mechanical Engineering.

Western Coals Coked

INVESTIGATORS at the University of Illinois, Urbana, Ill., working in co-operation with the United States Bureau of Mines, have succeeded in obtaining a good grade of coke from coals which seemed devoid of any coking property by the employment of a specially devised low temperature coking process. As a result of the process, valuable by-products, in the way of ammonia, gas and tar, are derived.

Experiments were undertaken in connection with an investigation by the Bureau of Mines of the smoke problem at Salt Lake City, Utah. It was found that coke was regularly obtained from only a few coals tributary to the Salt Lake City district, and, if the use of coke, a smokeless fuel, was to be increased in that city, it would be necessary to demonstrate the possibilities of coking coals not regularly used for that purpose. Six coals from various Utah districts were tested.

Although, so far as present standards of coking indications are concerned, the coals tested seemed quite non-coking, treatment by the methods devised by Professor S. W. Parr of the University of Illinois resulted in a yield of good coke amounting to approximately 60 per cent of the coal employed. The coke is dense and of good texture, and seems adapted to use as a domestic fuel and for metallurgical purposes. In some respects the coke seems superior to anthracite for use in domestic furnaces. Slightly more than 20 lb. of ammonium sulphate, valuable as a fertilizer, were recovered per ton of coal coked. The gas recovered as a by-product is especially suitable for utilization in city mains. The tar oils obtained should lend themselves readily to cracking processes, thereby furnishing a product suitable for motor-fuel purposes, and may also prove a source of creosote oil and other wood preserving materials. These tar oils, on account of their marked drying properties, may also be available for paint and varnish manufacture. Other uses suggest themselves, such as direct combustion in engines of the Diesel type, as fuel for steam generation, as a source of heat for metallurgical purposes, the carburetting of water gas, and as the source of pitch as a binder for the briquetting of breeze, lignite fuels, etc.

The results of the investigation are of two-fold importance, indicating the possibility of coking many coals not generally considered to have coking qualities, and also constituting a factor in the solution of the smoke problem in communities not favorably situated for the obtaining of smokeless fuel.

A GOOD rule for success is that of Thomas Van Alstyne. Mix brains with effort and use system and method in doing your work.

Notes on British Power Plant Practice

EFFICIENCIES OBTAINED, UTILIZING WASTE HEAT, FUEL AND COMBUSTION PROBLEMS. BY C. H. S. TUPHOLME

REGARDING testing efficiency of steam raising plants, says David Wilson, a prominent British combustion expert, it has been established that when using a high grade coal a modern boiler should give on test a combined efficiency of boiler, stoker, superheater and economizer of 85 per cent. In support of this, he gave the following heat balance:

	Per cent
Heat absorbed by boiler and economizer	85
Heat lost in chimney gases	9
Heat lost in combustible in ash	1
Heat lost in radiation	4
Balance unaccounted for	1
	100

This heat balance is for a complete boiler unit working at full normal rating of 5 lb. per sq. ft. of heating surface, with gases leaving the economizer at 370 deg. F., and an average CO_2 content of 12 per cent. The fuel was of high grade quality.

In present circumstances, the main factors militating against power plant efficiency are load factor, lack of requisite instruments for improving combustion, variation of fuel used, and the human element.

Provided turbine contractors call for greater boiler pressures, boilermakers will probably raise their pressures beyond 600 to 650 lb. which is now about the average in designs for large units. Superheat in the future will most likely be limited to 750 deg. by the behavior of the metal of the superheater under these conditions of pressure and temperature. As it is, boilers are now being designed and constructed for 1000 lb. pressure, but these are mainly for process work abroad, and do not embrace drums in the ordinary sense of the term. These are really heating boilers operating on a closed cycle so that the scale and water factors present no difficulties.

Final gas temperatures will be reduced to a very low figure, and furnace designers will introduce modifications to allow any fuel to be burnt on an efficiency basis. Should at any time the combustion of raw coal be prohibited, that is for steam generating plants, modern experience will, without difficulty, indicate a design for a furnace which will undertake the combustion of coke resulting from any fixed system of carbonization.

With these points in mind, it is unlikely that any far-reaching methods will be introduced in the boiler house itself to increase efficiency, and that there is but little margin between the best present practice and the best attainable.

The next big advance in British power plant practice will be the introduction into the engine room of some method for the recovery and utilization of heat which is at present only liberated to heat our atmosphere and rivers. It is disquieting to think that the best central station record in the world shows that we are able to convert only 18 per cent of the available heat energies in the coal to useful power purposes, and that the hopes of the immediate future are limited to about 25 per cent. A more general realization of the present best possible would result in an appreciable advance on the low average of 10 per cent now attained. As it is, the boiler is certainly doing its share of the work and power plant engineers must turn elsewhere for efficiency raising methods.

Surface combustion may possibly achieve something, though at present this principle does not seem to extend beyond the application of gas jets to each tube. Another possible improvement lies in the mercury boiler as a means of increasing the range of working temperature, considering mercury boils at 677 deg. F. at atmospheric pressure, and condenses at 455 deg. F. under a 28-in. vacuum. The mercury vapor is utilized in a turbine at 10 lb. pressure and returned to the boiler in a closed cycle. The circulating water of the condenser is converted to steam, which can be applied to any purpose.

A factor not always thoroughly appreciated by British power plant engineers is the selection of a coal fuel on an economic basis. Combustion engineers must insist on obtaining coal of a more uniform quality and ensure that the ash is removed at the proper place, which is the collier. It is a fact which reflects no credit on anyone that coal is the only commodity that cannot be purchased on a quality basis.

From the colliery owner's point of view, it is possible to specify a certain seam from which coal should be drawn, but not much more can be done except to state the quantity of ash present. From the coal owner's standpoint, it is impossible to sell on a calorific basis, and, if drawn on the point, they would merely put up the price.

The only methods at present available to improve the efficiency of power plants are: (1) proper selection of coal, (2) better supervision, (3) better and more combustion instruments, (4) better utilization of waste heat.

WASTE HEAT UTILIZATION IN BRITISH PLANTS

BRITISH iron and steel concerns would do well to take a leaf from the book of their American counterparts with regard to the employment of waste heat. The iron and steel makers in Britain complain that they cannot produce economically until the price of coal is brought down to a point not in excess of 100 per cent above prewar prices.

In some cases waste-heat boilers have been installed but, personally, I have seen very few where anything like real economy is attempted. While proper attention may be paid to the power plant proper, waste-heat boilers are installed in all sorts of awkward situations, without feed-water regulators, and, sooner or later the plant engineer declares the installation a failure, usually because their efficiency is destroyed by scaly tubes and grimy exteriors.

In other cases where due care has been devoted to the plant, a considerable economy has been effected and boilers will produce about 850 lb. of steam per ton of steel handled in the furnaces and soaking pits.

FUEL ECONOMY

COMBUSTION engineers in Britain are directing the

attention of suction gas plant owners in particular and fuel consumers in general to the necessity of employing other available fuels in the interests of economy. In many plants, some of which I have seen, coke and anthracite are being used where alternative fuels are available in large quantities and at low prices.

For instance, one small power plant, over which I was recently shown, was within two miles of three sawmills and a tannery and yet the engineer was utilizing a high grade Welsh coal in two boilers to generate steam for a comparatively small pottery. Now that plant has cancelled its coal orders and is burning sawdust, odds and ends of wood from the sawmills and also spent tan from the neighboring tannery. In other cases, plants which, during the recent strike, were compelled to turn their attention elsewhere for fuel, have found various otherwise useless materials to form serviceable fuels. Such a plant kept its machinery running on steam generated from nutshells, dried manure, sawdust and peat. In several cases, these plants will not return to coal until a more reasonable price for this fuel is stabilized.

Many other suction gas plants will, I think, introduce the producer designed by John Wells, consulting engineer to the Egyptian Government during the war. This producer, worked with such success by the Egyptians, is rectangular and built up of cast-iron flanged plates bolted together. The fuel is stored in an overhead hopper. Through the center of this hopper and extending into the producer is a rod with downward pointing spikes which serves to keep the fuel in a more or less compact mass.

This producer is being used with success in conjunction with vegetable refuse as a fuel, and various organizations are considering its adoption to burn ordinary dust-bin refuse.

How British Power Plants Fared During the Coal Strike

During the coal strike all kinds of fuels were used by British power plants in an endeavor to keep going. Among the fuels used were coal, coke, coal and coke-dust, outcrop coal plus, of course, a certain amount of incombustible matter including rock particles and dust, pit mound coal, tar and dried manure mixed or unmixed, peat, wood scrap and oil.

In one case, that of a Birmingham plant, fuel of a very low grade was burnt in conjunction with oil, the oil burners being fixed in front of the boilers and burning about 15 gal. an hour. This method proved more efficient after other means had been tried, namely, erecting the burners at the side of the boiler and burning 100 gal. per hour.

One plant, that of the Sheffield Corporation Electricity Department, spent about £15,000 or £20,000 more on fuel during the coal strike than it would have done in normal circumstances. During the same period, the demand for power fell by 50 per cent.

Many plants were able to operate by burning a mixture, 50 to 50, of oil and coal dust or pulverized low grade fuel.

Few plants utilized pulverized coal, partly due to the prejudice which still exists against it in this country on account of its reputation for explosiveness, and partly for the complaint of farmers in the neighborhood of such plants that their animals could not assimilate vegetable food which had become covered with minute particles of dust.

Steam Flow in Pipes

Steam Flow Chart for Superheated Steam in Standard or Extra Strong Pipe. By F. M. Van Deventer

THE MOST generally accepted formula for steam flow is Babcock's:

$$p = 0.000{,}131\left(1 + \frac{3.6}{d}\right) \times \frac{w^2 L}{D d^5} \qquad \text{formula (1)}$$

The formula as given may be considerably simplified by the following rearrangement:

$$p = w^2 L V F \qquad \text{formula (2)}$$

or

$$p = \frac{w^2 L F}{D} \qquad \text{formula (3)}$$

Nomenclature:

- p = pressure loss, lb. per sq. in.
- w = steam flow, lb. per min.
- L = length of pipe or section, feet
- D = average specific density of steam, lb. per cu. ft.
- V = average specific volume of steam, cu. ft. per lb.
  - Note: For superheated steam use D and V for the superheated steam—not the saturated value.
- d = inside diameter of pipe, inches
- F = a factor which is a function of the pipe diameter only = $0.000{,}131 \times \frac{d + 3.6}{d^6}$ (See Table)

Since the value F is a function of only one variable, viz., pipe diameter, d, it may be tabulated. The table herewith gives the exact inside diameter (*) corresponding to regular sizes of both standard weight and extra strong pipes, and the corresponding value of factor F to be used with formulas (2) and (3).

The proof of the adaptability of Babcock's formula to superheated steam is beyond the scope of this article, but is given in the discussion referred to in footnote (†).

An example of the use of the formula follows:

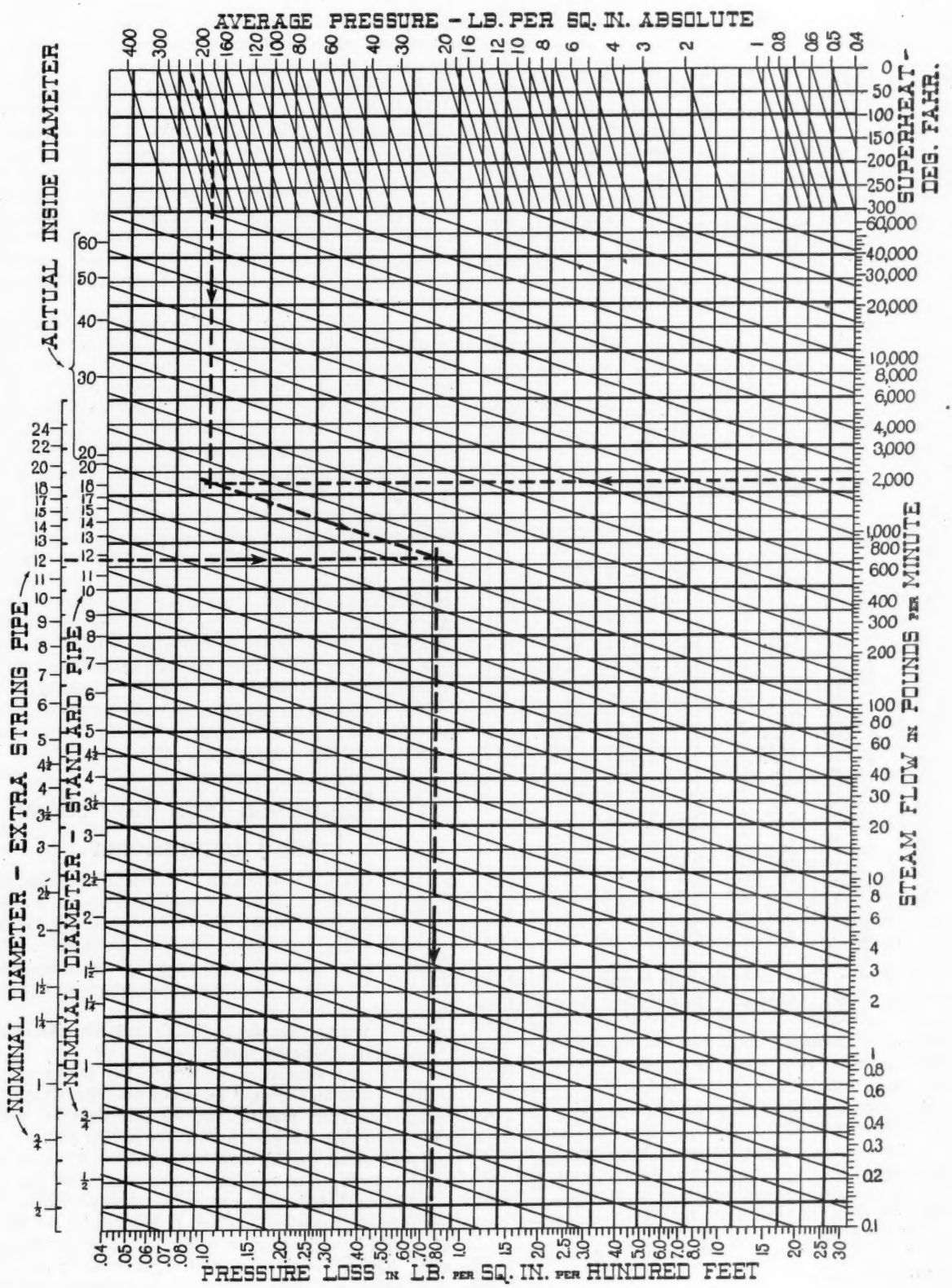
Data: Steam pressure—225 lb. per sq. in. abs.
Superheat—150 deg. F.
Steam Flow—2000 lb. per min.
Pipe—12 in. extra strong

Determine: Pressure loss per 100 ft. of pipe

Solution: Use formula (2)

$w = 2000$ $\quad w^2 = 4{,}000{,}000$
$L = 100$ ft.
$V = 2.56$ (from steam tables)
$F = 764.1 \times 10^{-12}$ (from table herewith)
$p = 4{,}000{,}000 \times 100 \times 2.56 \times 764.1 \times 10^{-12} =$ 0.782 lb. per sq. in.

* Diameters from "National Pipe Standards," by National Tube Company.



FLOW OF STEAM IN PIPES

Although the solution of formulas (2) and (3) is quite simple when the table and slide rule are available, the logarithmic chart herewith†, permits a quick and easy solution of flow problems, and involves an average error of not more than two per cent.

This form of flow chart was published in 1912, by H. V. Carpenter, but the original chart had three limitations, viz.: (1) The range of quantity of steam flowing was not extensive enough for many modern problems; (2) The steam pressure scale provided only for saturated steam, hence the chart was not directly applicable to superheated steam; (3) the pipe size scale provided only for standard weight pipe, hence the chart could not be used for extra strong pipe. The magnitude of the error resulting from the use of the standard weight scale for extra strong pipes is considerable and will be demonstrated later.

In view of the limitations enumerated, the chart presented here has been developed, which is universal in its application to steam flow problems.

The example indicated on the chart by the heavy dash line represents the solution of the same problem as calculated above.

TABLE OF PIPE SIZES

STANDARD WEIGHT PIPE			EXTRA HEAVY PIPE		
NOMINAL SIZE INCHES	ACTUAL INSIDE DIAM.	PRESSURE LOSS FACTOR "F"	NOMINAL SIZE INCHES	ACTUAL INSIDE DIAM.	PRESSURE LOSS FACTOR "F"
1/2	0.622	9551. x 10^{-6}	1/2	0.546	20.61 x 10^{-3}
3/4	0.824	1847. "	3/4	0.742	3408. x 10^{-6}
1	1.049	467.1 "	1	0.957	777.1 "
1-1/4	1.380	94.32 "	1-1/4	1.278	146.7 "
1-1/2	1.610	39.14 "	1-1/2	1.600	58.65 "
2	2.067	9.519 "	2	1.939	13.65 "
2-1/2	2.469	3510. x 10^{-9}	2-1/2	2.323	4938. x 10^{-9}
3	3.068	1047. "	3	2.900	1432. "
3-1/2	3.548	469.4 "	3-1/2	3.364	629.5 "
4	4.026	234.6 "	4	3.826	310.1 "
4-1/2	4.506	126.9 "	4-1/2	4.290	165.8 "
5	5.047	68.54 "	5	4.813	88.66 "
6	6.065	25.44 "	6	5.761	33.54 "
7	7.023	11.60 "	7	6.625	15.84 "
8	8.071	5531. x 10^{-12}	8	7.625	7482. x 10^{-12}
8	7.981	6870. "	9	8.625	3890. "
9	8.941	3216. "	10	9.750	2036. "
10	10.192	1612. "	11	10.750	1217. "
10	10.136	1659. "	12	11.750	764.1 "
10	10.020	1765. "	13	13.000	450.5 "
11	11.000	1080. "	14	14.000	306.3 "
12	12.090	658.3 "	15	15.000	213.9 "
12	12.000	684.4 "	17 OD	16.000	163.0 "
13	13.250	407.9 "	18 "	17.000	111.8 "
14	14.250	279.2 "	20 "	19.000	62.93 "
15	15.250	196.3 "	22 "	21.000	37.57 "
17 OD	16.214	143.0 "	24 "	23.000	23.54 "
18 "	17.182	105.3 "			
20 "	19.182	59.91 "			

Solution: Starting at the upper edge of the chart at 225 lb. on the pressure scale, follow down the guide lines until the 150 deg. superheat line is intersected, then vertically downward until the 2000 lb. per min. flow line is reached, then down the diagonal guide lines until the 12-in. extra strong pipe line is reached, and then vertically downward to the pressure loss scale, where the result is read as 0.78 lb. per sq. in. per 100 ft. of pipe.

The chart is just as flexible as the formula, that is: any one of the five variables may be unknown, and part of the procedure as outlined may be reversed, if necessary, in order to work from both ends of the chart toward the unknown variable.

In the Sept. 1 issue of Power Plant Engineering, an alinement chart was presented for the solution of steam flow problems. While the chart as published is correct and does represent the Babcock formula for saturated steam and standard weight pipes, it does not apply to superheated steam nor to extra strong pipe. The limitations of the chart in this regard were not explained in the article, and since the chart was recommended for "the solution of flow problems," it is quite possible that engineers will use it in cases to which it does not apply, and obtain erroneous results. As an example of such misuse, suppose the alinement chart referred to were unwittingly used to solve the problem given in a preceding paragraph, which involves superheated steam and extra strong pipe. The pressure loss so obtained would be 0.54 per sq. in. per 100 ft. of pipe, which result is 31 per cent lower than the correct result, 0.78 lb. per sq. in.

The error resulting from the use of the saturated steam scale for superheated steam is—16 per cent per 100 deg. of superheat, and the error resulting from the use of the standard weight pipe scale for flow in extra strong pipe varies from —10 per cent for 12-in. pipe to —55 per cent for ½-in. pipe, with an average error of —28 per cent for all sizes from ½-in. to 12-in., inclusive.

The use of steam gages to obtain the pressure drop in a pipe when the quantity of flow is to be determined, as proposed in the article referred to, is not recommended by the writer, since the pressure drop in the short length of straight pipes found in the power plant is very slight, and the ordinary gage has considerable lag, which might cause considerable error even if accurately calibrated gages are used. The method recommended by the writer is to run a small pilot pressure pipe, say ⅛ or ¼-in., from the two extremities of the straight pipe to a mercury manometer which must be built to withstand line pressure. Consistent results have been obtained in this manner, after the steam gage method had failed completely.

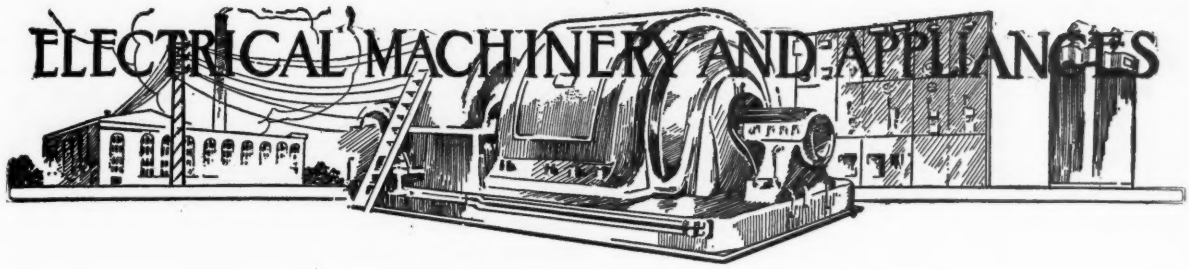
† This table and the accompanying chart were presented in the writer's discussion of D. E. Foster's paper, "The Effect of Fittings on the Flow of Fluids Through Pipe Lines," Am. Soc. M. E., February, 1921, and will appear in the Transactions, Vol. 42.

An Expression from the Federal Trade Commissioner

HOWARD THOMPSON, chairman of Federal Trades Commission, stated, in a recent address before the Colorado Bar Association, that he had never known a firm doing legitimate business to complain about any investigation made by the commission. The "howl" always comes from those who wish to profit by unjust means.

While not making the National Coal Association the "goat," Mr. Thompson said:

"The coal association went into the courts of the United States and secured an injunction restraining the commission from making further investigation, which had shown that the government was paying $20 per ton for coal which should have been sold for $7, at a reasonable profit. The coal association contended that the commission should confine its endeavor to interstate, and not intrastate matters. Lower prices will be the result of certain investigations to be conducted by the commission. These investigations will be made along economic lines which will assist in opening up the frozen zones of commerce and will directly aid the public. The commission has found very hearty co-operation on the part of business men of the nation."



Use of Flywheels on Electrical Machinery

ADVANTAGES AND WEIGHTS OF FLYWHEELS ON MOTORS AND APPLICATIONS IN INDUSTRIES. BY GORDON FOX*

MANY TYPES of machines require a heavy draft of power during a portion of their cycle of operation, together with a lesser demand over other portions of the cycle. A number of advantages may accrue through ability to equalize this demand upon the driving motor and upon the source of electric power.

A motor sufficiently large to handle the peak demand might represent an excessive investment. Moreover the average load would be too low for best efficiency and power factor. Equalization of load may lead to reduction in motor capacity. Not only is motor capacity affected, but also the capacity of control, conversion, transmission and generating equipment.

A uniform demand for power lends to economical generation or purchase. Where turbines and boilers can be maintained at economical loading, a distinct gain in economy results. The price of purchased power is usually based upon demand as well as consumption. Decreased demand may bring about a lower kilowatt-hour rate for the power actually consumed. Where large powers are involved, utility companies may restrict the peaks permitted.

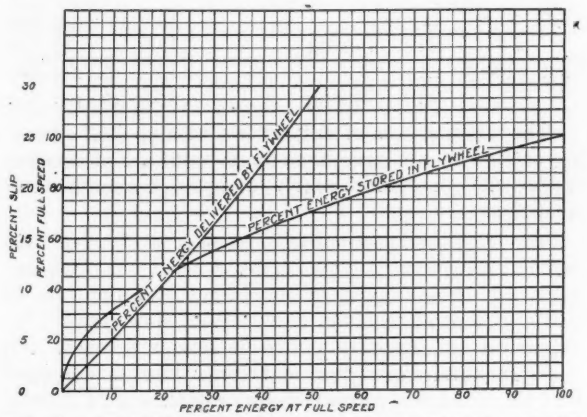

PERCENT SLIP
PERCENT FULL SPEED
PERCENT ENERGY DELIVERED BY FLYWHEEL
PERCENT ENERGY STORED IN FLYWHEEL
PERCENT ENERGY AT FULL SPEED

FIG. 1. RELATIONS BETWEEN SPEED AND STORED ENERGY, SLIP AND DELIVERED ENERGY

A flywheel is a means for storing and delivering energy for the purpose of transferring the demand upon the motor from one instant to another. It should be borne in mind that the flywheel can deliver only that energy originally received from the motor. A flywheel stores energy by virtue of its velocity. The energy stored is proportional to the square of the velocity. Energy can be imparted to the flywheel only by increasing its velocity and can be delivered only by decreasing its velocity. The curves shown in Fig. 1 indicate the variation in stored energy as a flywheel is accelerated to full rated speed and show also the per cent of this stored energy which may be recovered by permitting the flywheel to slow down or slip through a given increment of speed.

The formulas which apply to flywheels follow:

$$E = \frac{W V^2}{64.32} \text{ ft.-lb.} \qquad E = \frac{W V^2}{35{,}400} \text{ hp. sec.}$$

$$E = \frac{W R^2 N^2}{5870} \text{ ft.-lb.} \qquad E = \frac{W R^2 N^2}{3{,}230{,}000} \text{ hp. sec.}$$

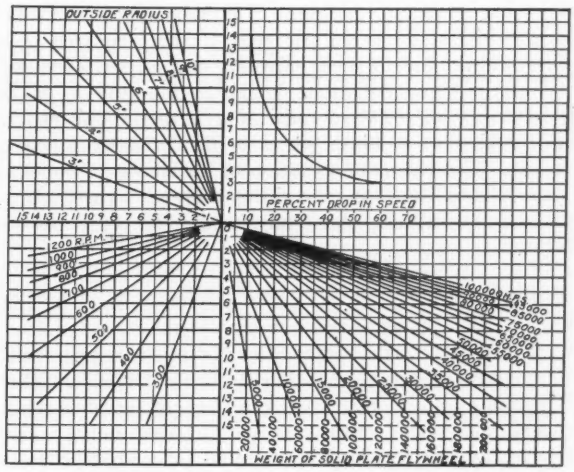


FIG. 2. CURVES FOR ESTIMATING FLYWHEEL WEIGHT

Where W = weight of flywheel — lb.
R = radius of gyration — ft.
V = linear velocity at radius of gyration — ft. per sec.
N = angular velocity — r.p.m.
E = energy stored in flywheel.

Any revolving mass has some flywheel effect and in some machines this effect in the actual machine members is, or can be made sufficient to meet the requirements. Flywheels are constructed from cast iron, cast steel or built up from laminated steel plates. Cast-iron wheels are used only for small sizes or where low speeds are permissible. Cast-steel wheels are used extensively for large powers at moderate speeds. Plate wheels are

*Electrical engineer, Freyn Brassert & Co.

used for large powers at higher speeds. The limitation rests largely in the permissible linear velocity at the periphery of the wheel, due to the action of centrifugal force. This effect is proportional to the square of the velocity, hence flywheels should not be permitted to exceed greatly their rated speeds and overspeed protective devices are desirable in many instances. The maximum safe speeds used for flywheels of the different types are as follows:

	Linear velocity at periphery, ft. per min.	
Type of wheel	Normal	Overspeed trip
Cast iron	6000	6600
Cast steel	16000	20000
Laminated plate	20000	24000

It is obviously desirable that flywheels be operated at speeds as high as may be feasible. The weight and cost of the flywheel, shaft, bearings and foundations are thereby reduced and the losses are also minimized.

In determining a flywheel application, the rotational speed and the amount of permissible slip are usually known, together with the amount of energy necessary in horsepower seconds or feet-pounds. A decision is necessary as to the type of wheel. This leads to selection of peripheral speed and thus to rim diameter. The chart, Fig. 2, may now be used to determine the weight necessary. First select point on curve corresponding to allowable speed reduction, then proceed horizontally to the left to intersection with line representing wheel radius, thence downward to line corresponding to normal full speed, thence horizontally to line representing energy required, thence down to reading of weight. The values given apply to plate wheels. For cast wheels the total weight will be 80 to 90 per cent of that required in a plate wheel, due to more effective disposition of material at the rim. An exact determination may be made by determining relative radii of gyration. The radius of gyration of a plate wheel is 0.707 of its physical radius. The radius of gyration of a cast wheel depends upon design but, for prevailing designs, figures about 0.80 of the radius. An analysis may be based on the formula:

$$\text{radius of gyration} = (R^2_1 - R^2_2) \div 2$$

Where R_1 and R_2 are the outer and inner radii of rim, hub or web, respectively.

Flywheels may be used directly in connection with the motor and attached to the motor or driven machine. Common applications of this type are punch presses and shears and some continuous steel rolling mills. Most frequently the flywheel is mounted on a shaft coupled to the armature shaft and rotating at the same speed. Sometimes the flywheel is mounted on a drive shaft which is geared to the armature shaft. For a geared drive, this practice has the advantage of relieving the gearing of peak loads and shocks. However, if the driven shaft is a lower speed shaft, as is frequently the case, a larger flywheel is required.

Application of Flywheels

Flywheels may be used in an indirect manner for load demand equalization. This is done extensively through the use of motor generator sets equipped with flywheels, notable in the Ilgner system. Most commonly the motor generator set supplies power to one or more motors having widely fluctuating loads. Mine hoists and rolling mills are the most common applications although ore handling gantry cranes have been supplied from equalizing sets. The primary purpose of the flywheel for such a set is to equalize the demand upon the source of electric power supply. In many cases, the cycle is such that the machine motor acts as a generator over a portion of its cycle and thus returns power to the flywheel through the temporarily motorized generator of the set. This occurs in some mine hoist work when the hoist overhauls and in reversing mill motor drive when the motor, in reversing, returns its kinetic energy to the system.

Flywheels are occasionally used as a source of energy storage to be called upon in case of failure of electrical supply. Such is the case in mine hoist service where the Ilgner set may deliver sufficient energy to complete one or more hoisting cycles and thus prevent possible imprisonment of men in the shaft.

In the selection of a flywheel for a given cycle of work, a choice is possible in the degree of load equalization. Where peaks are of long duration, a very large flywheel would be required to be effective. Where peaks are relatively short, a flywheel may absorb them, quite completely. As a general rule, the more complete the equalization of demand over a cycle, the heavier the flywheel required. The heavier wheel represents higher investment and greater power losses, but lowers the demand. The proper size of wheel then depends largely upon the relative value or importance of demand and power consumption.

The losses incident to flywheel operation are bearing friction and windage together with motor losses incident to the necessary slip. Bearing and windage losses have been found to have the following approximate values:

Plate wheel—exposed	1.25 hp. per ton
with housing	1.00 hp. per ton
Cast wheels—exposed	1.5 hp. per ton
with housing	1.25 hp. per ton

The windage loss of cast wheels with spokes, operating at high speeds, may be reduced by filling in between spokes with plates more nearly to approach smooth wheel conditions.

The fact has been mentioned that a flywheel can deliver energy only while slowing down, the amount delivered depending upon the extent and the rate of delivery depending upon the rate of slow down. To obtain the full measure of benefit from a flywheel it is necessary that the motor and control be so arranged that the speed will automatically drop through a greater range, with load peaks, than is the usual practice for such motors when no flywheel is used. A direct-current compound-wound motor has an inherent drooping characteristic quite adapting it for flywheel operation.

With induction motors, there are three devices used, namely, fixed secondary resistance, the notch back relay and the liquid slip regulation. Fixed secondary resistance may take the form of a high resistance rotor or an external resistance continuously in circuit with a wound rotor. These devices are relatively simple. They are well adapted and most used with the smaller drives such as shears and punch presses. The disadvantage of this arrangement lies in the fact that the speed droops under all loads so that, in the case of a load gradually applied, the flywheel may have delivered a considerable portion of its energy before the peak demand occurs. More-

over, due to the high slip at all loads, the secondary losses may be excessive.

The ideal speed control for a flywheel application is one in which the speed is well maintained for all moderate load values but, when overloads arise, the speed will tend to drop rapidly. This can be accomplished, with the wound rotor induction motor, by maintaining low secondary resistance for all moderate loads and by increasing the secondary resistance when the load reaches a stated value. This in turn, can be accomplished by either the notch back relay or the liquid slip regulator.

It has been previously stated that the energy delivered by a flywheel depends upon the range of speed through which it is operated. Small wheels are ordinarily operated through a range of about 10 per cent. Larger wheels may be operated through a wider range, up to 15 or 20 per cent. For emergency use a speed drop as high as 35 per cent may be utilized. It should be noted that 15 per cent slip corresponds to utilization of 28 per cent of the flywheel energy. With 20 per cent slip the energy delivered is 36 per cent. The gain due to greater slip constantly decreases. The proper speed range is a compromise. Wide range may increase the cost of motor and control and materially lower the efficiency due to slip losses. The amount of speed variation permissible may be determined by the requirements of the driven machine which may require that the speed be maintained within definite limits.

It might be noted incidentally that energy stored in a flywheel is not subject to control. For this reason, overload protection applied to the driving motor does not afford protection to the driven machinery. Care must be taken not to overstress a punch press or shear equipped with flywheel drive, lest a damaged shaft or housing result.

The previous discussion has dealt largely with flywheels arranged to equalize loads over a work cycle. Flywheels are sometimes used for a somewhat different purpose. With such loads as reciprocating air compressors and pumps, the torque required during a revolution pulsates regularly. Particularly where synchronous motors are used to drive, this torque variation tends to set up variations in angular velocity which may lead to cumulative swinging or hunting.

The amount of variation in angular velocity depends upon the range of torque values and upon the inertia of the revolving parts. Variation in velocity causes the rotor to take positions behind or in advance of normal for uniform rotation. In this direct-connected synchronous motor this involves displacement of the rotor field poles with respect to the uniformly revolving stator field. This causes momentary variations in torque developed by the motor.

The combination of the two varying torques, namely, load torque and motor torque, tends to set up oscillations. The extent of these oscillations, in practice, depends largely upon design factors in the motor which influences its angular displacement and depends also upon the inertia of the rotating parts. Should these factors be such as to cause the frequency of the load torque variation and the frequency of the motor torque variation to coincide, excessive hunting may result. This condition may be most readily adjusted by varying the inertia of the rotating parts to vary the frequency of the mechanical oscillations. This may be done through use of a flywheel. The use of damping windings on synchronous motors is found to alleviate greatly this hunting tendency.

Are Locks for Ground Detectors Necessary

By Frank C. Vogan

MANY curious experiences come to a fellow via the power plant, but the one about to be cited is certainly worthy of dishonorable mention. Who would ever think of trying to put it over on the ground lamp, and in a state that has the justice boasted by New Jersey?

In one of the largest industrial power houses recently inspected by the writer, the following instance came to

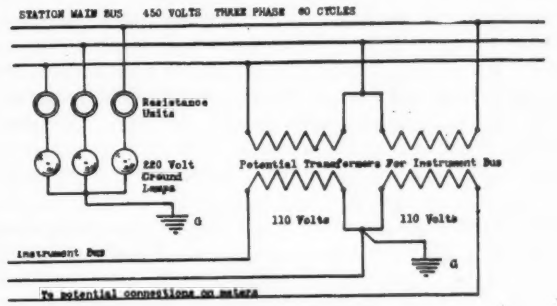


DIAGRAM SHOWING CORRECT CONNECTIONS FOR GROUND LAMPS.

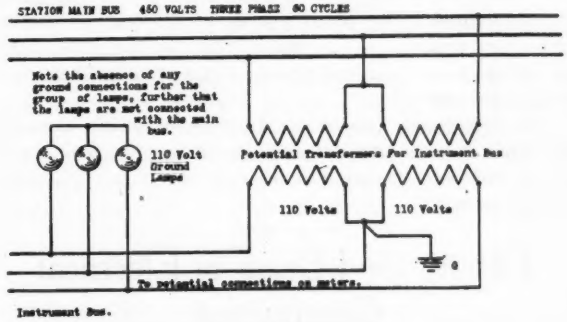

STATION MAIN BUS 450 VOLTS THREE PHASE 60 CYCLES
Note the absence of any ground connections for the group of lamps, further that the lamps are not connected with the main bus.
110 Volt Ground Lamps
Potential Transformers For Instrument Bus
110 Volts
110 Volts
G
To potential connections on meters.
Instrument Bus.

DIAGRAM SHOWING GROUND LAMP CONNECTIONS INCORRECTLY MADE.

CORRECT AND INCORRECT CONNECTIONS FOR GROUND LAMPS

light. It is fully understood that water and feeder cables often get into mixups that mean trouble; but when one adds to this a good portion of plant politics, it is hard to hazard the consequences. In the plant in question, current is generated at 450 v. three-phase and delivered by a rather complex network of underground feeders to various parts of the plant. The abundance of water about this plant is a mechanical blessing and an electrical curse. Many of the underground feeders lie in water for long periods and in many cases give no trouble, others are temperamental and either burn out or the water moves on to other levels. On the switchboard in the power house, there has been provided a regular three-phase arrangement of ground indicators in the form of three lamps.

At times these lamps, because of very moist conditions out on the lines, are forced to perform much overtime. These circumstances are annoying to the chief

engineer, to the plant electrician and have an unstabilizing effect on the plant politics. The operating engineer has absolute charge of the power house and the included electrical apparatus, therefore, every time a ground shows up, no time is lost in getting notice to the electrician.

About the only time the station electrician is welcomed in the power house is in the hour of trouble. He comes into the power house at the invitation of the engineer, and it is rumored he has often left through the same courtesies.

Well, in politics, no matter what brand, there always comes a day of accounting. One day, not so long ago, it appears that the electrician got his chance. Some special adjustments had to be made on the switchboard and the performance of the work was awarded to an outside contractor. Incidentally, the station electrician reasoned that what the engineer did not see would not worry him. The coming of the contractor's wireman and the smoldering thought in the electrician's soul worked for no good. An examination of the contractor's man has since brought forth the reason for the electrician's perpetual smile and the undisturbable ground detector. The electrician explained to the wireman that it was useless to worry the poor engineer with grounds and all such things, and further it would save wear and tear on the plant if the engineer could be silenced. Both being electrical men, they must have given each other the sine or the cosine with the result that the detector got immediate attention. Very effective treatment that detector got. They prescribed the full dose, and while other meters were given adjustments the wiremen did not overlook the ground lamps. The plant put in a phenomenal month free of grounds . . . that's what the log says. But lo, grounds are starting again; some outsider has just ruined the party.

To be serious, look at the diagram herewith, then go and look at your own detector apparatus and make sure it has not been contaminated; such things are possible, though criminal.

Fittings for I-Beam in Electrical Construction

By A. L. Harvey*

VARIOUS kinds of fittings have been on the market, some for a great many years, that are suitable for installing wires under I-beams. For open wiring, those shown in Figs. 1, 2 and 3 were designed more than 20 yr. ago for switchboard use, but have been applied to wiring on structural work. Figure 1 shows a fitting with insulators that could be used for wires running parallel to the beam. Figure 2 shows a fitting for running wires vertically past a floor beam. Figure 3 has two sets of knobs of different size. Similar fittings can be made to accommodate cleats instead of knobs.

These fittings are made of cast iron and are clamped to the beams by two setscrews. By changing the angle between the clamping throat and the insulator, different directions in the run of the wire with respect to beam flanges are provided for. Two or three rows of knobs can be used by using longer stove bolts. When three rows are used, it will sometimes be desirable to brace the upper end with a steel strap.

For conduit wiring the use of pipe straps was suggested for holding the conduit. By using two of the clamps shown in Fig. 4, the necessity of drilling the flange is avoided, and in some cases the conduit can be

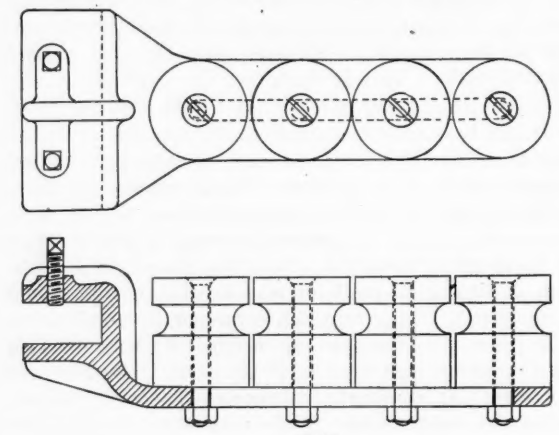


FIG. 1. BRACKET FOR WIRES PARALLEL WITH I-BEAM
FIG. 2. BRACKET FOR WIRES PERPENDICULAR TO I-BEAM

placed closer together. Figures 5 and 6 show heavier designs of clamps for one and two pipes. These two fittings were made for switchboard circuit-breaker structure where strength is required and are probably heavier

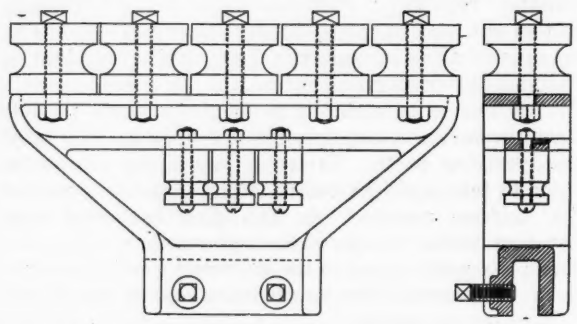


FIG. 3. DOUBLE BRACKET FOR WIRES PERPENDICULAR TO I-BEAM

than would be required for conduit work, except possibly where bends are to be supported.

In addition to the fittings shown there are other structural fittings used regularly in switchboard construction that often can be used to advantage in power-plant work.

The writer has been familiar with the use of the bracket shown in Fig. 2, in connection with the light wires on a bridge. These brackets were in use for over

*Control Engineering Department, Westinghouse Electric & Mfg. Company.

15 yr. when the wiring was changed from open to conduit.

The open fittings described above have been more applicable to straight runs than to bends. One method

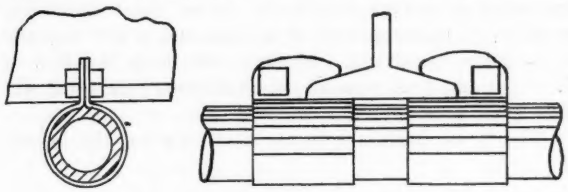


FIG. 4. PIPE CONDUIT CLAMP

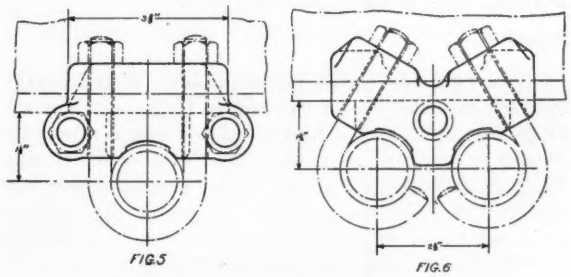


FIG. 5. ONE-PIPE CLAMP FOR HEAVY CONDUIT
FIG. 6. TWO-PIPE CLAMP ON I-BEAM

that has been quite satisfactory and very substantial is to dead-end each set of wires and make the connections between the two sets by jumpers.

Rheostats for Large Currents

FOR LOADING generators or transformers under test, it is often impossible to find lighting or power use which is sufficient or can be varied as desired. In such cases water rheostats are the most convenient means of using up energy, and they may also be used in emergency for regulating speed of motors or exciting current of large generators, though, due to the unstable resistance, water rheostats for the last two uses will call for considerable attention.

Shape and arrangement of the plates of the rheostat will depend on the water supply and container available, as smaller plates may be used when running water is available to carry away the heat.

In one test, described in the Power User, of a 1000-kw. generator, ⅛-in. wrought-iron plates, 6 ft. by 3½ ft., were used spaced 2¼ in. apart by wooden battens, like battens being placed on the outside and the projecting ends used to clamp the structure together by means of through bolts. At the upper ends, the plates were perforated with ¾-in. holes to aid circulation of the water. Insulating wedges were placed between the ends of the plates and the bolts to prevent contact, and hold the plates in position. The construction is shown in Fig. 1.

For raising and lowering, a rope sling was carried to the outer ends of the upper bolts and attached to the hook of a rope hoist.

This arrangement, in a fairly hard water easily took care of 2000 amp. at 550 v., with water circulating continuously.

Some points to be looked out for are: Make sure that the tank or place in the stream is free of obstructions and of metal, loose or fixed, against which the plates might touch so as to be short-circuited or grounded. Try raising and lowering the plates several times from full immersion to clear of the water, to make sure that there is no bad swinging and nothing will interfere with the leads; then lower to a convenient position and attach the leads. There should be a main switch near the rheostat to which leads from generator and plates are carried, so that the man at the rheostat

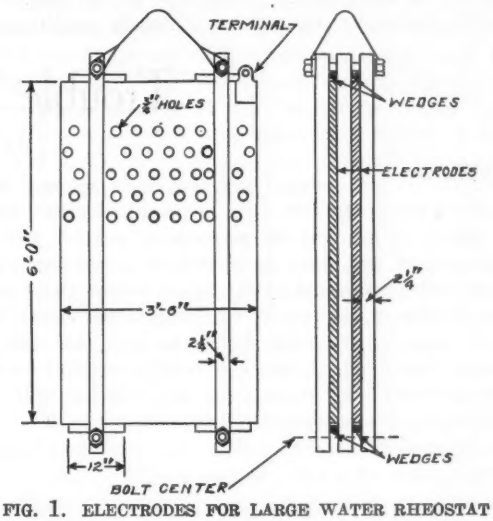


FIG. 1. ELECTRODES FOR LARGE WATER RHEOSTAT

can break the circuit in case anything goes wrong. Also a signal system for "raise," "lower," "slow" and "stop" should be arranged between the test room and the rheostat location.

When it is certain that everything is working freely, and that the leads are firmly secured, set the plates about 6 in. into the water and throw on current. Then lower gradually until full load is carried, and mark this on the plates as a dead line. Try raising and lowering until the man who is to handle the rheostat knows about

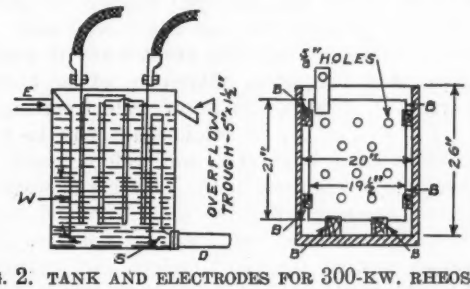


FIG. 2. TANK AND ELECTRODES FOR 300-KW. RHEOSTAT

where it stands for various loads, and how much ½-in. change in position will change the load.

For a 300-kw. generator, 550-v., the device of Fig. 2 was used, the wooden tank being 20 in. square by 26 in. deep, and ⅛-in. plates 19½ in. wide by 21 in. deep. The plates were held ¼ in. from the sides of the tank and ¾ in. apart by wood spacers having grooves cut in them, and were kept away in the other direction enough to give room for water inlet, baffle and outlet pipe. The grooved bottom cleats allowed 1½ in. below the plates for water to circulate, and sediment to settle. Connections were as shown, alternate plates being joined.

At W a wooden baffle forces the incoming water

from pipe E to the bottom of the tank, and it is carried away by pipe S which is long enough to extend to the top when vertical. This outlet pipe swings on elbow S so that the water may be kept at any height desired, the position of S being controlled by a cord carried to the top of the tank and made fast there to a wood cleat.

Flow of water needed will depend on the temperature allowable. For a rise T in temperature, the gallons needed per hour will be $343 \div T$ per kilowatt of power to be dissipated. From 100 to 150 deg. F. is allowable for outlet temperature if steady conditions are to be maintained. It is best to get the correct adjustment of flow before turning on current to start the test.

The same device may be used for lower voltage, but may require the addition of a small amount of soda to the water to reduce resistance. If so, the soda should be added a tablespoonful at a time and a few minutes allowed for dissolving. In such case, keep the flow of water as small as possible to avoid carrying away the soda.

The 5/8-in. holes are to assist circulation throughout the tank.

Trouble Hunting---VII

By John Pierce

BELIEVE ME when I say that it is no easy thing for a man only 5 ft. 4 in. in height and who weighs 185 lb. to get into the manhole of a boiler, and circulate around, and when he is directly under the leak of a leaky valve from one of the other boilers there seems to be no way at all that he can remove his entire body out of range of the leak, for to be only that tall and to weigh that much anyone can readily see that he must be pretty well built up on the bay window side, and equally so to the rearward. But I went into those boilers. I'd said I would even if it took the hair off, and it did take some of it off. I took plenty of time in each one and gave each one, in her turn, a thorough going over. The stays and braces were O. K.—the fuse plugs were omitted when the boilers were made—there was no oil showing in them to speak of, but there were signs of scale. I did not hurry my inspection in the least, for two reasons: one was that, once inside, I hesitated to try to get out again; the other was, that once out I knew I'd have the same struggle to get into the next one.

Finally, however, I had gone through them all, finding all in good shape except one, which I ordered reflued at once. Then I began a still hunt to see if there were any mechanical contrivances which could be used in removing the scale, and was well pleased to find two new "Dean" hammers that had never been used. The old chief, who was by this time about ready to pack up, his notice being completed, offered to bet me a box of good cigars I'd not get 125 lb. of scale from any one boiler. I took him on, for while scale may be pretty thin, a boiler has a large area, and scale is heavy. We got rigged up and put one of the hammers to work. We worked that hammer faithfully for 10 days and weighed the scale. The old chief lost, for there was over 500 lb. of scale in each of the eight boilers. Of course this added a little more onto my evaporation, which, by having been helped a little here and a little there was steadily getting more respectable with each boost. The water for our boilers was taken from the main pond and pumped into a tank. By the time it reached the heater it was at atmospheric temperature, and left the heater at an average of only 120 deg., as we had then but the feed pumps working exhaust to the heater. The hot well of the condenser carried water at and near 125 deg., which was, as a rule, about 50 deg. higher than the atmosphere. So I decided to pipe from the hot well to the heater, which I did, and tried that out, but found that the water was now so hot the feed pumps would not handle it, the level of the water in the open type heater being a few inches below the level of the pumps. That left me only one of two things to do—either lower the pumps or raise the heater. Therefore I raised the heater and set it up 6 ft. above the level of the pumps. We then took stock of what we had accomplished from start to finish on the evaporation end of the work as compared to oil used, and found we were evaporating 375,000 lb. of water and using 27,000 lb. of oil to do it with, while we were formerly using the same amount of water and 42,000 lb. of oil to obtain the results finally reached with something over half that amount.

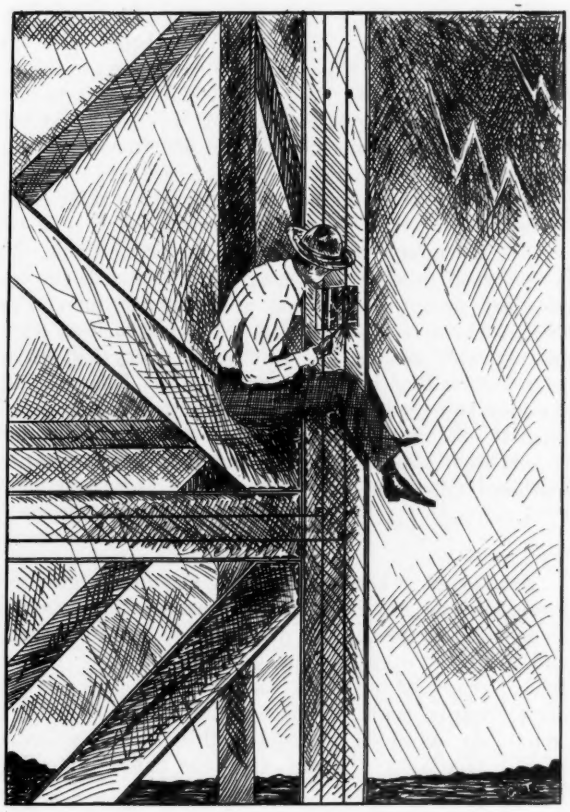
You may be sure that I was some pleased with myself, and thought I'd certainly get a good fat raise, and a lot of high-falutin praise over what I'd done. I heard nothing official, however, from general headquarters, though our local manager patted me on the back, declared me to be a "hell of a good man" and asked me if I wouldn't go personally and "fix his Ford." After the nice bouquet he had handed me, I could hardly refuse him, so I fixed Lizzie. Now laugh—but I did—and I wondered and wondered, until I finally learned that a new man was in charge of that department under whose head I belonged—a man just out of college. He came, eventually, to the sunny south; had one eyeglass and wore leather leggins, big wide-spreading pants like a soldier, and a white helmet. Ye gods and goggle-eyed sunfish! but he was a funny looking expert to dare the wilds of oildom. He visited me, in my little office, in the course of time, and he brought up a number of fine points about the game and how she should be played—I got so dog-goned impatient I could hardly wait until the son of a gun got on the fuel question—but he did at last—ah boy "ain't it a grand and glorious feelin'!" He swung around and began to go over the reports—ran his finger to fuel and water consumption, turned round to me, put in his glass eye and said (gee, I was hugging myself): "Why cawn't you get your evaporation up to whah it belongs?"

Did you ever fall very far? Well, I did, and I did it right then, I'll say it hurt—"Why cawn't you get your evaporation up to whah it belongs?" I decided then and there that I would tell the manager to get him a new man to take Uncle John's place, and I gave him, that day, 90 days' notice. He asked me to reconsider, and for my reasons. I did not care to give my reasons, as I was so mad I could hardly talk.

Our fine haired expert left the next day and while jogging along in his private car with the president of the company, ran into a young revolution that was just

trying itself out, and which shot up the train a few. When the train reached Eagle Pass our little hero stayed not nor tarried—one trip in the woolly jungles of Mexico was all he cared for.

The manager must have guessed what my grievance was for he came to me and laughingly told me about it and said I ought now to withdraw my resignation; however, I had, on the day I turned it in, wired another firm regarding work and they said I could come to them as soon as I finished this job, taking charge as master mechanic. So when the manager asked me to stay, I had already signed on for another job. He asked me to get as much accomplished as I could in the way of little changes for the betterment of the place before I left. I agreed to this, and made some few changes that were a satisfaction, even if they saved no money.



I BROUGHT THE WIRE DOWN IN A GRAND FLOURISH AND AROUND THE LINE SCREW

The same night I agreed to this, there came up a terrific storm and the water fairly poured from the sky. There was not a single "cutout" switch on any of the many lines carrying the incandescent lamps, and the fuse blocks were the old-fashioned wire fuse type. They were all fastened on the iron supports and trusses around the works, and exposed to the elements. That night, I was called during the storm as the lights were out on many of the circuits and the night crew of electricians were out of fuse wire. After I had issued enough more wire to them, I decided I'd get busy and help put in a few. They had the several ladders of their department, so I decided I'd climb up the truss work and put them in that way. I had noticed in the daytime that they frequently did this, the trusses being dry, of course, and the 110-v. direct current not bothering them to any extent. Well, there's no fool like an old fool. I never took into consideration that I was wet and that the trusses were wet, and that we both were going to stay wet as long as it kept raining, and up I went. It was some job, too, for my bay window front kept interfering with my liberty of movement, and my rear view seemed awfully heavy and inclined to pull me down.

I did, however, at last, get up, took my screwdriver and backed off the screws, tied the load end in and set up a screw, brought the wire down in a grand flourish and around the line screw—oh! whew!—yes, I had my belly up against the truss—all of me was up against it—and—well, I burned the seat out of my pants and it wasn't the bottled lightning that did it, either. I didn't fall, but I did come down—and I'll tell the world I came down fast and a cussin' all the way.

Well, one thing I did, and I did it next day, was to put in a "cutout" switch at the beginning of every circuit, and every branch circuit, and each one carried a pair of screwed fuse plugs, and had all the old ones taken down and destroyed. Never again will I consent to have such things used around a plant where I'm in charge—no sir; why, somebody might get hurt with them things. While we were working on the fuse plugs and "cutouts" I found a lot of circuit breakers in the warehouse and decided I'd put them up. I had noticed that in "tapping" the settling tanks, the laborers often got their tapping rods against the trolley lines and the coils and then out went the trolley circuit breaker in the plant and every moving motorcar stopped. This was considerable of a nuisance for the fellows would not cut off their current when this happened, so that the engineer, in replacing the breaker, often had to stand and hold it for some time or it would not stay in. After I had given each track its own independent trolley line, separated from the others, and joining the main line by a circuit breaker set a little under the one in the plant, I had no more trouble along this line. My next "fixin'" was the generator itself.

Formula for Strength of Rope

HOW STRONG is a rope? At the Bureau of Standards laboratories in the Department of Commerce tests have been made that have resulted in answering that question with a formula.

For three-strand regular lay manila rope from ½ to 4½ in. in diameter, the following computation will give the breaking load of the rope:

The average breaking load in pounds equals 5000 multiplied by the diameter of the rope in inches, multiplied by the diameter of the rope increased by one.

This will give, of course, the average maximum weight that the rope will hold, but the working load or the load that an engineer may apply with proper safety and precaution would be considerably less than the load given by the formula.

Other data on rope are contained in Technologic Paper of the Bureau of Standards No. 198, by A. H. Stang and L. R. Strickenberg, which has just been issued.

BEWARE—indolence is a slow poison.

Design and Construction of Safeguards

To Give Safety and Permanence and Increase Production. By Sidney J. Williams*

PRACTICALLY all machine accidents can be prevented by properly applied safeguards. Some foremen contend that guards curtail production, which may be true in the case of guards for the point of operation, when the guards are first installed and the workmen are not accustomed to their use. But in many instances such guards have actually increased the production. Guards for belts, gears and the driving mechanism of machines, if properly applied, will have no effect on the operation, or will actually increase the production by giving the workmen a greater sense of security. Much depends upon the installation of guards of proper design, suitable for the work at hand.

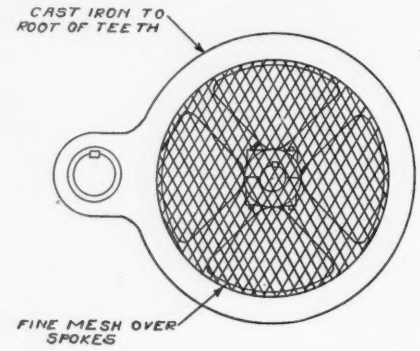


FIG. 1

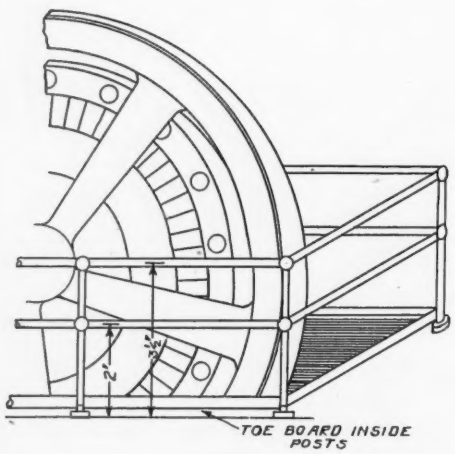


FIG 2

FIG. 1. GEAR GUARD WITH TEETH COVERED AND SPOKES ENCASED

FIG. 2. SAFE DESIGN FOR RAILING AROUND FLYWHEEL PIT

A safeguard should be so designed and constructed that it will prevent accidents on the part guarded—not only to the operator at his regular work, but also to anybody who slips, falls or carelessly touches the machine. As the guard should not interfere with production, otherwise it is liable to be taken off, in designing a guard it is generally wise to consult the man who will use it. In general, a guard should be attached to the machine and not to the floor; if attached to the floor, the connection should interfere as little as possible with the operation.

The door or removable section provided to give accessibility for oiling, inspection and repair should be hinged or otherwise attached to the remainder of the guard, or to the machine, so that it is not likely to be left off permanently. It is desirable to interlock the guard with the operating mechanism, where possible, so that the machine cannot be operated unless the guard is in place.

Guards should be so placed as not to interfere with cleaning and sweeping around the machine, kept generally about 6 in. above the floor. They should be strong enough to resist injury and keep their shape, incombustible guards being preferred. "Metal guards look as if you wanted to; wooden guards look as if you had to," but where subjected to acid or fumes, wooden guards may be necessary.

As to the actual method of constructing safeguards, the engineer is not so much concerned as this is the duty of the safety engineer or the master mechanic. He is concerned, however, in seeing that the guards provide adequate protection without unnecessarily interfering with machine operation, with provisions such as doors or removable sections so that the machinery will be accessible for oiling, inspection and repairs. That machinery may be guarded in accordance with recognized safe practice, the important points in safeguarding power transmission apparatus and a few of the more common machines are given below.

Gear Guards

All gears, wherever situated, should be guarded, preferably by cast-iron guards, because they may be made to fit more snugly, present a better appearance, and protect the gears from dust and injury. Guards for a variety of machines, and in many sizes, may be more cheaply made of sheet metal. Gears should be completely encased; or, where this is impracticable, should have a band guard with side flanges extending inward beyond the root of the teeth. If there is a spoke hazard, the gear should be completely enclosed, or filled in between the spokes.

Belts and Pulleys

Horizontal belts, ropes, or chains, which come within 7 ft. of the floor or working level, or which must be approached while in motion, should be guarded on the sides and bottom. Overhead belts 6 in. or more in width and running 30 ft. or more per second, even when more than 7 ft. above floor or working level, if located so that, should they break, they would endanger persons below, should be guarded underneath. All vertical and inclined belts (except belts 1 in. or less in width) should be guarded to a height of 6 ft. from floor or working level. If the highest part of the belt is less than 6 ft. from the floor level, the guard may extend over the top of the belt instead of being carried higher.

* Chief Engineer, National Safety Council.

The following requirements for guards are recommended by the National Safety Council:

Distance from Thing Guarded, In.	Height of Guard, Ft.	Maximum Size of Opening, In.
0 to 4	6	½
4 to 15	6	2 in. square or 1 in. between slats
15 to 20	3.5	Standard railing preferably filled in.

Shafts, couplings, clutches, collars and set screws should have all dangerous projections removed, where practicable, and should be guarded if within 7 ft. of the floor or working level.

Circular Saws

Every circular saw should be equipped with a hood guard of light but substantial construction, counterbalanced or easily adjustable so that it will rise when stock is introduced. It should permit a clear view of the saw at the point of operation, and should be rigidly supported in such manner that it can be swung out of the way when necessary, yet cannot be readily removed from the machine. A saw guard which works hard, or requires frequent adjustment, is of no value because the men will not use it. Every rip saw should be equipped with a splitter.

Jointers

Every hand-fed jointer should be equipped with a cylindrical cutter head, and a guard should be provided to cover the head. The best type of jointer guard is that which covers the head at all times; the guard, or a portion of it, moving when the stock is fed in. The guard should be provided with a counterweight or spring so that it will return to its original position when not in use. For feeding short pieces, use a push-block.

Railings

Railings used to guard machinery or floor openings, or on platforms or stairways, should be at least 3½ ft. high and should have an intermediate rail midway between top rail and floor. If used around a flywheel pit, floor opening or platform, they should be equipped with a toeboard. Railings should be provided on all open sides of stairways and platforms; on at least one side of enclosed stairways not more than 3½ ft. wide, on both sides of stairways over 3½ ft. wide, and on both sides and in the center of stairways over 7 ft. wide.

What Is the Most Economical Belt?

By W. F. Schaphorst*

A BELT USER recently wrote to a dealer in belts and asked: "What kind of belt is the most economical in the long run?"

The dealer replied: "The belt that will transmit the most power per square foot of its area during its natural length of service is most economical."

This answer may be correct; in fact, it is correct; but, now that the belt user has the answer, what is he going to do with it? The answer is certainly vague. Very likely the user knew that much about it before he asked the question. What the user wants to know is, I believe: What kind of belt is the most economical in the long run—leather, cotton, rubber, camel hair, balata, etc.

In spite of all the substitutes that have been manufactured, leather belting still predominates. It is the superior belting for general machine shop work. Where belts must be shifted from pulley to pulley there is nothing better. In fact, where finger shifters are employed nothing but leather belts should ever be permitted. Leather belts are also superior for use on quarter turn drives, reversing drives, or wherever there is constant side pull, slipping, jerking, etc.

The cotton belt has largely replaced the leather belt in outdoor power transmission as in connection with threshing machines. It has also largely replaced the leather belt in industries where much dirt and grit is encountered as in cement mills, brick plants, flour mills, or crushing plants, etc. It is an excellent belt for use in hot and dry places. It is very strong and durable, but must never be used in connection with finger shifters because such shifters wear the edges rapidly causing them to fray and unravel and fail prematurely.

There are a number of rubber composition belts on the market, and it is claimed by many users that these belts are superior to the leather belts, which may be true for their own conditions. It is the writer's belief that the rubber belt is superior to the leather belt for use in wet or damp places, as in paper mills, dye houses, laundries, etc. In fact, it has practically replaced the leather belt in all of these industries. Like the cotton belt, however, it must never be used in connection with finger shifters because of the fact that it has a fabric core which gives it its strength and which will cause premature failure when the edges are once worn or frayed.

The life of a belt depends largely upon the good start that it gets, in the same way that the success or failure of a man depends largely upon the care given him during his childhood. Therefore, when putting a new belt on the pulley too much care cannot be given to it to see that it is put on right. The ends should be cut absolutely square. If the joint is glued, there should be no "kinkiness" in the belt.

Shafts and pulleys should be alined as perfectly as possible so that there will be no side slipping, no forcing, no everlasting running off and no sidepull.

Occasionally there is something inherently wrong in the belt itself so that after a few days of operation it will run crooked in spite of the care first given it. This may be due to the fact that one side of the belt was stronger than the other, consequently the weaker side stretched most and as a result the belt began operating imperfectly. When this happens the belt should be taken off and the imperfection carefully removed. Unless this is done, it is obvious that there will always be some side slip or side pull and the life of the belt will be materially reduced. It pays to watch new belts carefully and see that they get a proper start in life. By so doing, much money will be saved in the end.

It is impossible, of course, to answer the foregoing question completely and with absolute accuracy; but the writer feels that his reply is at least more definite and more satisfactory than the reply given by the dealer.

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Service

THE POSITION OF THE HOTEL POWER PLANT FOR RENDERING SERVICE IS COMPLETE. BY GEO. TALCOTT INGERSOLL

IT HAS BEEN said that all the hotel has to sell is service. That is true in the highest sense. Service is the keynote of the greatest teaching ever given to the human race. It is a pleasure to me to state here that many large hotels in this country today are doing genuine service work. The officials of such hotels are men of vision, keen business judgment, and common sense. They know they must sell service through their employes. They know that it pays to appeal to the best there is in each employe, and they have devised ways and means for bringing out and developing the best. They are doing constructive work.

The modern hotel is really a community affording unusual opportunity for co-operative and community work, and when actuated by right thinking and the true spirit of service the result will be cumulative and will make an impress upon every guest and extend to the home life of every employe. This is constructive work of the highest type, for it is human thought and energy working in harmony with nature's laws so directed as to promote utility, simplicity and efficiency in every department of life. The keynote is service.

During the war there was a call to service, and millions of brave men and women enlisted in this service for their country and for humanity. As a nation and as individuals, we have now equally grave problems to solve, and there is another call to service.

We are controlled and influenced more than we realize by prejudice, custom and habit. We let things we know are wrong run along year after year because it takes a fight, a struggle and a campaign to overcome our old habits. How long shall we allow prejudice, habit and custom to control our thought and energy when there is great need of constructive work?

We have an enormous indebtedness which is a direct tax on every man, woman and child in the country. It is true we have great resources; but the careless unnecessary waste and loss in every department of life, if allowed to continue, will soon deplete these resources. What is saved in the elimination of waste and loss will furnish new capital which can be applied to reduce our indebtedness.

As the unnecessary waste and loss in power plants throughout the country is great and serious, there now comes to every power plant man another call to service, a call to help eliminate the great waste and loss. I am sure that every hotel manager and power plant man is ready and willing to do his share in this call to service by reducing the waste and loss in power plants. Perhaps we need more common sense such as used by the successful business man. He takes a careful inventory each month or year; he makes careful note of mistakes which have caused waste and loss, and avoids similar mistakes. Then using his own and the experience of others in similar work, he plans a new campaign for the future. This is constructive work and the use of it by the modern hotel will be of great help.

We have said that there is a new call now to service to help reduce the great waste and loss in the land and thus accumulate savings with which to pay off our debt. The hotel is for service. It has service to sell. In selling this service, the hotel has at the same time a wonderful opportunity to do constructive work by spreading the call to service. The hotel is a most fitting and valuable place to do that work because to the hotel come the ablest and most prominent business and professional men from all parts of the world. What impress can the hotel impart to every guest that will act as a stimulant to that guest to do constructive work and to pass on the word to others?

I am not advocating anything new or strange. There is nothing new in the world. It has been in existence for hundreds of millions of years. It is based on law and order. Continents have come and gone; civilizations far grander than any we have today have come and gone. They have left some evidence of their greatness in many parts of the world—the great pyramids and temples, and other great works in Egypt, Persia, Java, Greece, South America, Central America. Great teachers and great leaders have come and gone, but the keynote and substance of their teaching has been the same throughout the ages and that is service.

Where do we stand today? Are we applying for our own good the experience of others who have gone before, or are we, like the prodigal son, wasting our substance in riotous living?

However we may fool or cheat ourselves, there comes the warning which Paul gave: "Be not deceived; God is not mocked. What a man soweth that shall he also reap."

That is one statement of a great fundamental law in nature—the law of Cause and Effect, or Compensation. We cannot cheat God and nature.

Is it not time that the world give pause and consider, "What mean ye by this Service?"

New Steam Properties Experiments

PLANS are being worked out for careful checking of the data on which tables of the properties of steam are based, and for extending experiments to higher and lower ranges than heretofore attempted. At present, specific volumes of superheated steam are not well known above 150 lb. pressure, or for high degrees of superheat; latent and total heats are known only up to 190 lb., and not quite satisfactorily even below that limit; heat of the liquid, and the fundamental heat unit are not known with the accuracy to be desired.

The Research Committee of the American Society of Mechanical Engineers has agreed to administer a program of experiments to be carried on at various laboratories to supply these missing data, covering specific heat of water up to atmospheric pressure; pressure, temperature and volume of superheated steam over as wide a range as possible; density of water over a wide range; the Joule-Thomson cooling effect in superheated steam up to 600 lb. and 600 deg. F.; specific heat of superheated steam at constant pressure. Work will take, it is estimated, 3 yr. to complete, and the results will be embodied in a steam table to be published by the A. S. M. E.

THOSE WHO fight for what is right always have lots of opposition, but a satisfied conscience atones for many of the blows that land.

Faulty Boiler Feed Supply Piping

OIL IN BOILERS CAUSED BY LOW LEVEL OF WATER IN SUPPLY TANKS. BY H. A. JAHNKE

A NUMBER of years ago I took charge of a plant which consisted of one boiler, engine, and other apparatus which generally make up a plant of this size. For feeding the boiler, an iron tank was sunk into the ground below the engine room floor as shown in Fig. 1. From this tank, the feed pump and injector received the water. The tank was supplied with water from the city main; also all drains from the engine and pump were piped into the tank and whenever there was a heavy rain storm, the water from the factory yard would also run into the tank. The engine room floor being much lower than the yard surface, the water would run through the door, then into the tank.

The first time I cleaned the boiler, I found it in bad condition, as there was considerable scale and cylinder oil in it, all due to the way the feed water was treated in the tank below the floor before it entered the pump or injector. The trouble was mostly due to the fact that the supply of water to the tank was regulated by a valve which was either opened or closed more by the engineer,

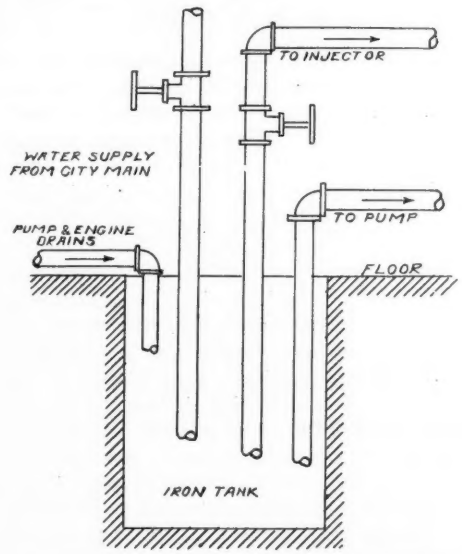


FIG. 1. FEED WATER TANK BELOW FLOOR

depending on the amount of water used. In this hand operating affair of the water valve, the tank was either overflowing or empty and whenever it got empty the feed pump would draw all the oil and other foreign matter that floated on top of the water and force it into the boiler.

In thinking the matter over and trying to find a way to remedy this trouble, I wondered of what use the tank under the floor was for furnishing water to the pump and injector. There was no gain in this, nor in collecting the drains from the engine and pump cylinders into the tank; it only made matters worse by mixing the water in the tank with more or less cylinder oil.

Then I decided to cut out the tank entirely and connect the pump and injector directly to the city main, as there was a closed feed water heater in the plant through which the pump forced the water into the boiler. There was much trouble in keeping the lower joint from leaking, due to the fact that there always was boiler pressure in the heater. To overcome this difficulty, I later on changed the piping system so the water from the city main would pass through the heater first, then to the pump; in this way there was less pressure in the heater, hence no trouble with a leaky heater joint.

ANOTHER FAULTY ARRANGEMENT

IN ANOTHER instance where a large wooden tank was in use for furnishing water to a boiler feed pump, the suction to the pump was arranged as shown in Fig. 2, at

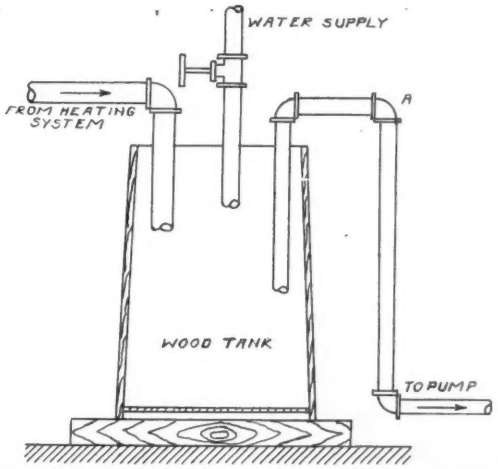


FIG. 2. FEED WATER TANK PIPING WHICH GAVE TROUBLE

A. In this case, also, the tank was supplied with water from the city mains and the supply valve regulated by hand; the returns from the heating system were run into the tank, as were the drains from all steam using apparatus as exhaust steam was used for heating. There was an oil separator in the exhaust line of the engine, still, more or less oil got into the tank, hence they got more or less oil into the boilers causing leaky tubes, etc. In this case, also, most of the trouble was caused by the tank running empty at times when the pump would draw the cylinder oil that was floating on top of the water and force it into the boiler, through a closed feed-water heater.

As they had much trouble with the boilers on account of the oil getting into them, my advice was asked. I suggested that they do away with the tank and connect the feed pump directly to the city mains; this, however, the concern did not care to do because the returns of the heating system would go to waste.

Of course there were many ways of overcoming the trouble caused by the cylinder oil getting into the water tank, but the concern did not care to go to much expense to install new equipment and make other changes. I suggested overcoming the trouble as much as possible in the following way. In place of running the suction pipe into the top of the tank, as shown in Fig. 2, I advised them to run it into the side near the bottom of

the tank and then equip the water supply pipe with some type of automatic water regulating valve; then the danger of the tank running empty would not be so great as where the water is regulated by hand, thereby doing away with the tank running empty frequently and drawing the oil that may be on top of the water into the pump. I also advised that the tank should be emptied frequently and given a good scrubbing with soda or soda ash, so no great amount of oil would accumulate on the sides of the tank; by this method, no oil found its way into the boilers.

Automatic Water Valves and Screens Should Be Used

Where it is absolutely necessary to use tanks of wood or iron for carrying a supply of feed water and the injector or feed pump receives the water directly from this tank, it is much better to connect the outlet pipe into the bottom or side of the tank, then arrange the pipes as shown in Fig. 3, at A, or B, then by placing

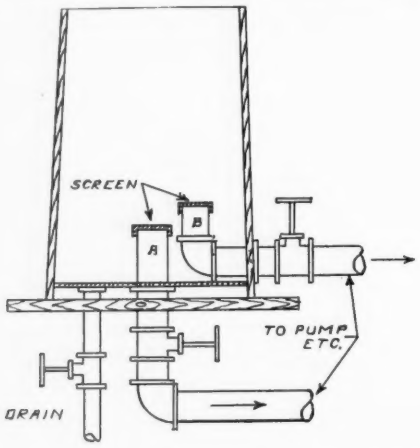


FIG. 3. TANK WITH PIPE CONNECTIONS AT BOTTOM

a screen over the opening of the outlet pipe there is no danger of drawing any foreign matter into the pump or injector. Letting the outlet pipe project some distance above the bottom of the tank, as illustrated, will also prevent the outlet pipe from getting clogged up from any sediment that may be in the water, as most of the sediment will settle to the bottom of the tank where it can easily be removed whenever the tank is cleaned without causing any trouble as would be the case if the outlet pipe were flush, or nearly so, with the bottom of the tank, when some of the sediment would be drawn into the pipe and cause trouble.

To show why the outlet pipe of a water tank should be screened, I relate the following. The outlet pipe on a large water tank used for storing water and boiler feeding was arranged similar to that shown in Fig. 3 at B, but without the elbow and nipple facing up; neither was the opening of the pipe screened. One day it was necessary to draw water from this tank for boiler feeding. After sufficient water was obtained and when about to close the valve to cut off the water from the tank, it was noticed that the valve could not be closed, due to some obstruction in the valve, which was of the gate type. It was necessary to empty the tank entirely, so the valve could be taken apart, when a piece of wood was found in the bottom of the valve between the two seats which was wedged in quite tightly. In trying to close the valve, the piece of wood had to be cut out with a wood chisel. Thereafter a wire screen was placed over the opening of the outlet pipe, also an elbow and nipple was placed on the outlet pipe.

To regulate the water in a tank, it is much better to have some automatic type of valve in place of regulating the water by hand, as is done in many plants. In this way the tank is either overflowing most of the time which is wasting water which if paid for by meter rates amounts to quite an item during a year's time, or should the tank run empty, which also occurs frequently where the water is regulated by hand, there exists the danger of drawing oil into the pump or injector should any oil get into the tank from the heating system, drains, etc., or any other foreign matter may be drawn into the pipe that may be floating on top of the water. This trouble is eliminated where valves of the automatic type are in use and kept in good working order, so they keep the water at a certain height in the tank.

Rules for Operating Small Oil Burning Boilers

By W. A. Darter

BURNING fuel oil under small boilers is much simpler than burning coal, yet it is much easier to waste fuel. This is because it is so easy to use excess air with the fuel oil, and excess steam in the atomizer, For the same reason, it is easier to burn a cold boiler when it is started up.

Starting Up a Cold Boiler

In starting up a cold boiler, the fuel oil should be sprayed slowly and ignited with a torch of some kind. Care must be taken to see that the boiler does not become full of unburnt gases due to the oil flame going out, under which condition an explosion is likely to occur. To avoid an explosion, if the fire goes out, and the boiler becomes full of oil gas, shut off the oil burner long enough for the unburnt gases to be drawn out of the boiler and out of reach of the oil when it is ignited again. If the fire snuffs out, give the boiler a little more draft. Too much steam or a small amount of oil pressure will have a tendency to blow the fire out. The engineer should never be looking into a boiler when conditions are such that a small explosion may occur.

Atomizing the Fuel Oil

The fuel oil must be thoroughly atomized before complete combustion can be expected. The atomization of the oil depends upon its viscosity; also upon the steam or air pressure, if steam or air is used, and upon the oil pressure if mechanical burners are used. The viscosity of the fuel oil can be decreased by heating it before it enters the burners. This heating of the oil is necessary when using low Baume gravity fuel oil. If steam is used to atomize the oil, it should be dry and a steam pressure ranging from 60 to 100 lb. be used according to the percentage load carried by the burner. The oil pressure carried should be less than the steam pressure.

Combustion

Good combustion takes place when the oil is properly atomized, the proper amount of air is given to the fire, and the two thoroughly mixed. Preheating the oil and air will aid to better combustion. A short white fire will indicate too much air. A long gray or blackish flame will indicate too little air. A yellowish white and orange fire will indicate about the right amount of air. With good combustion the CO_2 meter will record about 12 per cent.

Draft on Boilers

A boiler burning fuel oil should have as low a draft in the combustion chamber as is possible to carry and keep the fire burning. This pressure will be close to zero, or atmospheric pressure. The draft pressure in front of the damper should be regulated by the damper according to the steam load carried on the boiler, or the amount of air needed to burn the oil fed to the boiler. Controlling the air given to the boiler, by the doors in front of the boiler, creates a greater suction in the boiler; and a greater leakage of air through the setting is the result.

To decide the amount of draft necessary to carry a given steam load, start the damper wide open and gradually close it until the fire takes a yellowish-white color and the smoke stack shows a slight haze. The stack gases temperature will vary with the steam load also, and if the fire is in good condition will vary with the draft on the boiler.

Feed Water to the Boiler

The feed water should enter the boiler as hot as it is possible to make it economically. The water level should not reach the point where there is danger of the boiler priming and a steam engine cylinder being wrecked. It also should not be out of sight in the gage glass. The feed water should be gradually fed to the boiler, and at the same rate steam is leaving it.

Blowing a Boiler

A boiler should be cleaned of soot at regular intervals. These intervals depend upon the amount of unburned carbon deposited in the boiler. The interval at which water should be blown from a boiler depends on the nature of the water used. Very hard water containing vegetable matter requires frequent blowing to carry away the sediments. High efficiency requires clean boilers.

Controlling the Steam Pressure

It is easy to control the steam in an oil burning boiler. This is because a great deal of oil can be burnt in a short space of time. A fireman should be careful not to give a boiler too much oil during peak steam loads and burn the boiler. This danger can be guarded against by limiting the boiler to a given amount of draft. Limiting the draft limits the amount of air drawn into the boiler and consequently limits the actual amount of oil that can be burnt under a boiler.

Cutting Out the Boiler

Cutting a boiler out of service for repairs is the reverse process of bringing in a boiler. The fire should first be cut out and then the boiler closed up tight as possible. As soon as the boiler stops producing steam the boiler, if not connected with a stop valve, should be cut off from the steam header. Sometimes a boiler cannot be closed up completely, and a draft of cold air continually passes through the boiler. If it is a water-tube boiler, and the first row of tubes only are exposed to this air first, then these tubes will naturally contract a great deal more than the hotter tubes further up in the boiler. As a result these lower tubes will have a tendency to stretch, and when the boiler is again brought into service these same tubes will come in contact with the fire first and they will have a tendency to expand more than the rest. This continual process will cause the lower tubes to warp in all directions, but generally down. To keep these lower tubes from contracting so much faster than the rest of the boiler, the steam pressure of the boiler can be lowered by letting the steam escape gradually from the top of the boiler. It is self evident that this steam pressure cannot be lowered faster than the temperature is lowered of the boiler setting, but by this process the temperature of the entire boiler can be lowered much faster and with less strains.

There are times when it is necessary to shut a boiler down and make quick repairs, and this method enables the engineer to cool his boiler off rapidly; but the engineer must not at any time cool his boiler down too rapidly, and cause excessive strains in it.

It is reported in Compressed Air that Germany has started an immense program for superpower stations. The country is to be divided into districts, each utilizing all the hydroelectric power possible, and supplementing this by huge power plants at the coal mines. Electric power will be supplied to all industrial plants from this district system.

It is expected that the resulting lowered cost of manufacturing will go far toward paying the war indemnities.

The plan is backed by the Economic Parliament, which includes the big mine owners and manufacturers of Germany, and it is expected that a large number of the new power stations will be working in 1923. Stock in the enterprise is to be owned by national, provincial and municipal governments, by mine owners, manufacturers and workers, control resting for the present in the employer group, but with workers represented on the directorate. Development of the plan will be interesting to watch in relation to similar plans for other countries, as well as for its effect on the economic status of German manufacturers and finances.

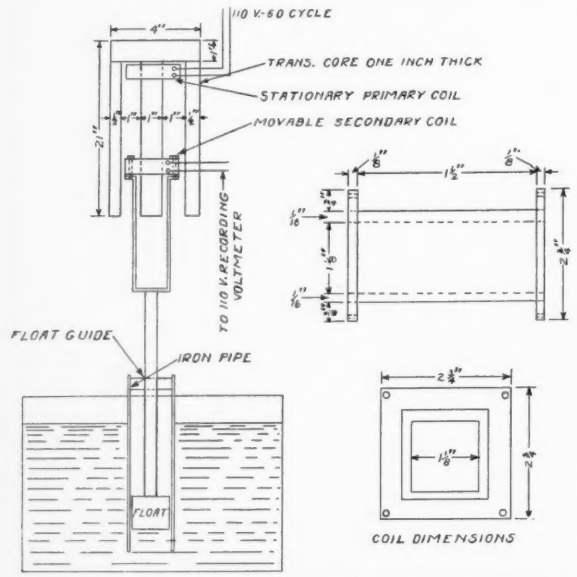
Scored gasoline engine cylinders are being repaired in England by filling the grooves with an alloy of copper, tin, nickel, and antimony, melted in with a gas blowpipe. For water-cooled cylinders the alloy has a melting point of 450 deg. C.; but for air-cooled, the melting point is 900 deg. C. and the cylinder is heated to redness before putting in the alloy. The union of metals and hardness of the patch seem satisfactory. Excess of metal is scraped away to conform to the bore of the cylinder.

"An ounce of push is worth a ton of pull."

Homemade Liquid Level Indicator

A HOMEMADE electrical liquid level indicator was desired, so an auto transformer was designed with 30 different taps, brought out to a contact board which had a sliding contact on a float arm, to make contact with the different taps on the transformer as the float went up and down; but on account of the difficulty of keeping the contacts in line in order not to slip any of the taps on the transformer, it proved unsatisfactory.

A transformer was then constructed with a movable secondary coil as follows: Enough old transformer sheet iron, about 1/64 in. thick, and 4 in. wide, by 21 in. long, to make the core 1 in. thick, were obtained. The iron was cut out so as to have the magnetic circuit closed, at first; that is, the iron core was closed at both ends instead of one end open as shown in the drawing. The principle of the transformer was to have a varying voltage on the secondary coil, which was mounted on top of the float arm. As the float moves away from the primary coil, the secondary coil will be cutting less lines of force, on account of the magnetic leakage between the primary and secondary coils, and less voltage induced in the secondary coil. So the iron core with both ends closed did not work out satisfactorily on account of there not being a great enough leakage of the flux between primary and secondary coil to vary the voltage. The secondary coil would move through its entire travel without changing the voltage very much.



LIQUID LEVEL INDICATOR CONNECTIONS AND DETAILS

The idea was conceived to make the core twice as long, which did not improve matters. Then the core was constructed as shown in the drawing, with one end of the core open, which caused enough magnetic leakage to vary the voltage full scale while the secondary coil moved through its full travel. The spool for winding on the coils was made out of fiber, the ends being ⅛ and the body 1/16 in., and 600 turns of No. 22 single cotton covered enameled magnetic wire was wound on each coil. The secondary coil was mounted on the float arm with ⅛-in. bolts, the float arm was constructed out of yellow pine as shown, and the float made out of galvanized sheet iron.

The reason for adopting a recording volt meter is that special charts could be made up that would read in gallons or cubic feet.

MARIN PHILLIPS.

Reducing Bearing Troubles

TAKEN AS a general rule, there are usually more troubles to the bearings of machinery in the summer time than there are in the winter months, provided, of course, that the machines are running about the same length of time in both instances.

One reason for this, perhaps, is that during the summer month there is more dust blowing around to find its way into the bearings, cause increased friction, excessive heating and final shut-down. This situation may occur in conjunction with clogged oil channels and oil pipes so that the flow of oil is reduced at the time when it is needed more than ever. The chief cause of greater bearing trouble during the summer months is, however, that the highest temperature during this time affects the lubricant efficiency by reducing its viscosity.

The viscosity of an oil is its internal friction or its resistance to flow. Viscosity decreases rapidly with increasing temperature; meaning that an oil becomes more liquid and, inversely, loses some of its "body" and so is more liable to be squeezed out from between the journal and bearings. Frictional resistance varies with the pressure and velocity of the frictional parts (journal and bearings) and with the viscosity of the lubricant. Animal and vegetable oils retain their viscosity better than mineral oils. The most rapid decrease in viscosity with all oils occurs between 60 and 100 deg. F.

In choosing an oil, its viscosity at the temperature to which it will be subjected is of utmost importance. In this connection, it may be pointed out that the actual temperature of the oil film between the frictional surfaces is always considerably higher than the indicated temperature of the bearing. Usually the viscosity of an oil is given for a temperature of 100 deg. F. If the lubricant is to be subjected to radically high temperatures,

the viscosity at the corresponding temperature should be known. To take this precaution is the first step toward reducing bearing troubles during hot weather.

A secondary but at the same time very important function of a lubricant is to carry off the heat generated by the friction of the bearing. Where a bearing is water cooled the effect of high temperatures can, of course, be largely counteracted by increasing the flow of water. This simple expedient is not followed as often as it might be. Incidentally, a considerable saving can be brought about in the water consumption where water is allowed to flow to the sewer after use by installing a storage tank, say on the roof, a pump and re-circulating the same water many times. With a forced oiling system, increasing the flow of lubricant is generally a simple way of keeping the journal temperature down and so preventing troubles due to high temperature. Increasing the velocity of the oil has the added advantage that dirt is washed out of the bearings and accumulations in the oil pipes are not allowed to build up to any extent.

The question of what lubricant to buy is a very broad subject and one beyond the scope of these remarks. It is a truism, however, that the best oil is the cheapest oil in the end when lubricating costs, the cost of shut down, of replacements, lost time and similar items of expense are taken into consideration. A good oil may be circulated hundreds of times and still be good, often better than when first used. A good oil does not "wear out" mechanically, although it does darken in service. As important as the choice of an oil is the use of a filter. A filter extends the life of an oil enormously and so reduces lubricating costs.

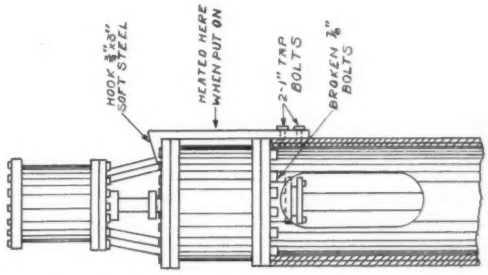
To reduce journal troubles during hot weather, or under conditions except intense cold the best advice is to use a good lubricant, employ a generous quantity of oil circulated rapidly and filtered frequently. Make sure the oil has the proper characteristics for the condition existing. Keep the oil clean and free from dirt and dust. If water cooling is available, use it to counteract high temperatures. Many bearing troubles start the day the oil is bought, because the improper choice was made or because the oil was never given a chance to function properly.

G. HARVEY.

Some Country Power Plant Experiences

SEVERAL YEARS ago there was an electric light plant, situated in the woods, and supplying four neighboring villages with light and power. The equipment was all secondhand. There were three 72 in. by 18 ft. horizontal tubular boilers; the feed water being supplied from a brook, about 100 ft. distant, with 15 ft. lift. It was necessary to clean the frog-spawn and dried grass from the foot-valve on the pump-suction, often, several times a day. A Corliss engine was belted to an alternator, and a tandem compound slide valve to another generator, each supplying the busses with 2200 v. I was employed to take charge of this plant, and one May evening I arrived just at starting up time and found the Corliss engine running.

By the time I had donned my overalls and made a cursory examination of the equipment, the load had come on heavy enough for the other unit to be put in service. As the second engine came up to speed I noticed that the joint between the low pressure crank-end head and the frame was "breathing" and when the load was thrown on it got worse. I could stick the small blade of my knife all the way to the handle, in the joint, at every stroke. The flange was inside of the frame, and on examining it with a light I found that three of the 7/8-in. studs were broken off flush with the flange. Upon inquiry, I was informed that "it had always been so." When the Italian fireman would allow the water to get too high in the boilers (which, I noticed, he frequently did) it would come chugging over into the cylinders, putting extra strain on that joint; consequently, during that run I didn't walk around behind that engine any oftener than was necessary. We had no facilities for drilling out the broken studs, neither could we spare the engine long enough to take it down. There was a forge and some scrap belonging to the railroad nearby, so the next day we started to make the temporary repair, as shown in the accompanying sketch. I found a piece of soft steel, 3/4 by 3 in., and long enough to reach from the head end, past the length of the cylinder, and about



TEMPORARY REPAIR MADE ON ENGINE CYLINDER

8 in. onto the frame. We bent the end, upsetting the bar to make 1¼ in. in the throat of the hook; this was made to fit between the stud-nuts on the head end of the low pressure cylinder. Holes for two 1-in. tap-bolts were drilled in the other end; and the same in the cast-iron frame, but 3/32 in. farther towards the shaft, and tapped. When all was in readiness, the bar was heated in the center, and put in place, the tap-bolts quickly screwed tight; then the hose was turned on the hot strap-hook; and that joint never "breathed" again; and after being painted the same color as the engine, the hook could scarcely be noticed.

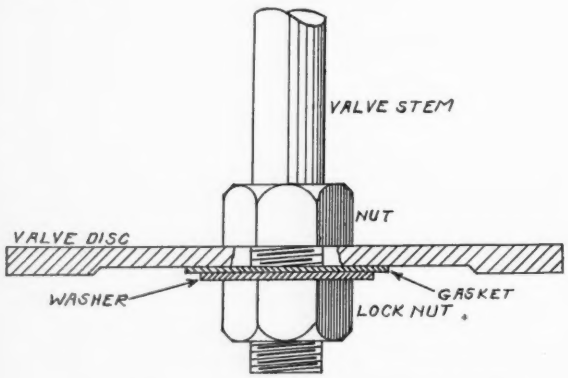
One alternator developed a hot bearing on the pulley side. Not being, at that time, familiar with that type of machine, I started, in the usual way, to relieve the trouble by changing the oil, cleaning the bearing and rings and slackening the belt, without results. It would run hot. On removing the bearing cap I noticed the end next the machine was bright, indicating wear. On the commutator end there was an iron case about 14 in. diameter secured to the pedestal of the bearing the use of which I was ignorant. Noticing wires running into it, I removed the screws which held the cover in place. I then saw that it was designed for balancing the armature, i. e., keeping it central in the field. As I recollect it, it had an armature attached to the shaft with magnet-coils on each side stationary in the case. The vibration of the machine, on the wooden foundation, had broken off one of the wires, thereby putting the device out of commission, allowing the shaft to run hard to the pulley end. A new piece of No. 12 wire cured the trouble.

One day we could get no water for the boilers, and was forced to shut down. We overhauled the feed-pump and foot-valve at the brook, but could not raise water. The pump would seem to take hold, then slip and race. The next thing to do was to dig up the suction pipe. We started to dig at the building and uncovered the pipe as far as the railroad track (about 70 ft); fortunately for us, it was buried only about 18 in. deep. At this point we found several small holes eaten through the pipe, but at the surface the holes were started the size of a dime. It must have been electrolysis, but why at this point and nowhere else on the pipe? I never could solve that mystery. I have had trouble with electrolysis in direct current plants, but never before, nor since, in plants making wholly alternating current.

M. M. BROWN.

Back Pressure Valve Repair

IN OUR PLANT, practically all the exhaust steam is used for heating and drying, escape to the exhaust head being through an old style globe back-pressure valve. Steam seldom escaped from the exhaust head, so I was surprised one day to see quite a stream of it soaring upwards.



TEMPORARY REPAIR ON BACK PRESSURE VALVE

The back-pressure gage showed ½ lb. low, so we tried adding a small weight on the valve arm, but with little effect. I wanted to wait until Sunday before taking the valve down, thinking that valve disc and seat needed regrinding, but the next day steam was roaring out of the exhaust head, and I found the valve lever hanging much lower than was necessary to close the valve, the back-pressure gage showing almost zero.

That night we took off the bonnet and found that the valve stem had punched through the disc; also the end of the stem was badly battered and worn out of shape. But we had to make a repair and no lathe or shaper to work with.

So I filed up the end of the stem and, with a pipe die, put a thread on the end. This took a lock nut; next the old disc and a cloth insertion gasket; then an iron washer and another lock nut. I screwed all tight and spread the thread with a center punch to prevent loosening.

It was a rigid makeshift and did not allow the disc to seat properly, but it served for two days until a new disc and stem could be procured and fitted.

R. A. CULTRA.

Emergency Starting Rheostat

SOME TIME ago, we were called upon to do something for a 35-hp., 250-v. motor. One of the resistance coils of the starting box had burned in two and the resultant arc had caused considerable damage to several of the other coils; the motor could not be started with the starting rheostat and it was essential to the welfare of the esablishment that this motor operate.

After first opening the main switch we disconnected all wires from the terminals of the starting rheostat, then we secured an oil barrel and two large iron plates which would just go into the barrel nicely; 9/16-in. holes were drilled into the center of these plates and a ⅝-in. eye bolt secured to one. The other one was placed in the bottom of the barrel and secured to it by a ½-in. bolt, the head of which was countersunk into a large washer, a rubber gasket being placed on the under side. The line wire which connected with the starting box was lengthened out and secured to the ½-in. bolt through the bottom, after which the barrel was set up in position near the starting rheostat and filled almost full with water.

The armature lead going to the starting box was extended over to the barrel with sufficient surplus to reach to the bottom of barrel. This wire was then made secure to the iron plate with the eye bolt secured to it. A small half-inch rope was then tied to the eye bolt the other end of this rope passing over a pulley suspended over the center of barrel by means of a bracket made from some 2 by 4-in. material and the field lead going to the rheostat was extended over to the barrel and a small plate attached, after which this plate and wire dropped into the barrel to a depth of about one foot. This accomplished, the switch was closed and the plate suspended by the rope lowered into the water.

When the plate was submerged a couple of inches, the motor did not start, so we added salt until we secured such conductivity that when the upper plate touched the surface of the water the motor just started to rotating slowly and as the plate was lowered, the motor speeded up, attaining full speed when the two plates were together. The motor was stopped by pulling the switches.

This temporary rheostat continued in service until repairs could be made to the original starting box.

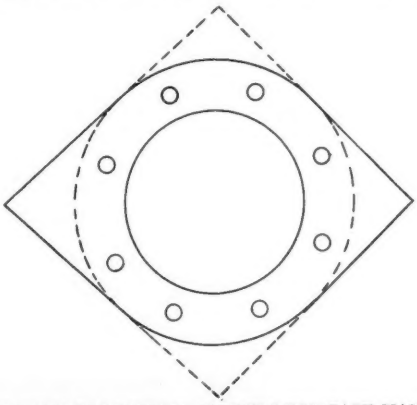
JOHN C. KAHL.

BULLETIN No. 123 entitled "Studies on Cooling of Fresh Concrete in Freezing Weather," by Tokujiro Yoshida, recently issued by the Engineering Experiment Station of the University of Illinois, deals with certain experimental work carried on at the Engineering Experiment Station of the University of Illinois with the object of obtaining data on the length of time required for concrete of a given temperature to lose its heat and become cold enough to freeze when it is exposed to temperature lower than the freezing point of water. Some experiments were made on the protective effect of coverings. While it is probable that these experiments do not give complete data regarding concreting in freezing weather under all possible conditions, it is considered that they throw some light on the behavior of fresh concrete at low temperatures, and indicate the necessity of protection or other precautions.

Easy Way to Replace Gaskets

SOME TIME ago we took over a war-time plant, and prior to putting it in service we had to go over pretty much all of the equipment and piping and remedy the shortcomings of the poor mechanics who did the original job. One of the jobs was to go over practically all the steam mains and put in new gaskets, the material originally used being of inferior quality.

We undertook to replace the gaskets without completely taking down the lines, and we at first experienced some difficulty in slipping the round gaskets between the flange faces until we hit upon a little kink which saved considerable amount of time. Instead of cutting the gaskets round, we cut them in the shape as shown in solid lines on the accompanying drawing, the result being that there were two fins, one on each side, which acted as gripping pieces by means of which the gasket could be quickly pulled up in place between the



GASKET WITH PROJECTING CORNERS FOR EASY HANDLING

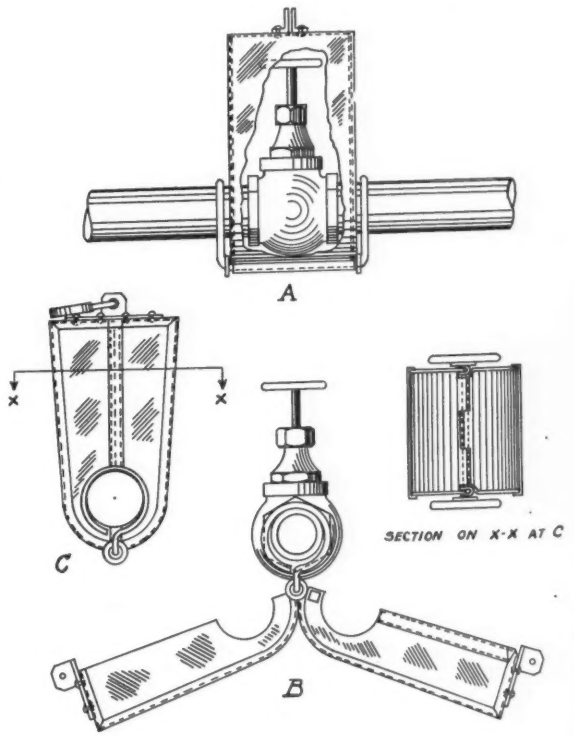
flange faces and then held in place while the bolt holes were being punched out and the bolts put in place. Once the joint was made up, these two projecting fins were cut off with a sharp knife, leaving a finished job. While in some ways this method resulted in a waste of packing, it more than paid for itself in time saving.

M. A. SALLER.

Safety Clamp for Valves

IT IS of great importance at times that certain valves should not be operated by others than those authorized to do so. At other times, it is important that certain valves should not be tampered with or moved during certain periods of time or while certain work is being carried on. To insure compliance with orders or rules concerning important valves, the device shown in the accompanying illustrations has been designed and patent applied for by the writer.

Essentially, the device consists of two parts hinged together which clamp over the entire valve and may be locked in closed position. A wire which forms the hinge extends on both sides of the device and is bent to



VIEWS OF SAFETY CLAMPS FOR VALVES

encircle the pipe next the valve and hold the clamp from dropping when not locked over the valve.

HARRY HASLER.

Packing Kink

WITH REFERENCE to Homer Johnson's "Packing Kink," described on page 925 of the Sept. 15 issue of Power Plant Engineering, I wish to state that this form of packing is not new, letters of patent No. 745,459 covering this packing having been granted to me Dec. 1, 1903.

Although I have used this form of packing for many years and have always found it to give excellent results, it was never put on the market. A prominent packing manufacturing company considered the making and marketing of my packing, but owing to the fact that they already carried some 200 styles of packing and because of the cost of special machinery and establishing trade on this special line, and inasmuch as they had es-

tablished their trade on their then present product, did not see it to their advantage to market it.

I met with some trouble in getting manufacturers to take it up; but, as stated, the packing was a wonderfully durable and cool running packing. I discovered the advantages of this type of packing 22 yr. ago in operating a high-speed engine in an electric lighting plant where the load varied from an overload to about one-fourth load and on the light load other packing would overheat and burn. This gave much trouble in the splash system and when my new scheme was applied it proved a success. Whereas I had to pack the piston rod every two or three weeks, with this packing I ran a full year.

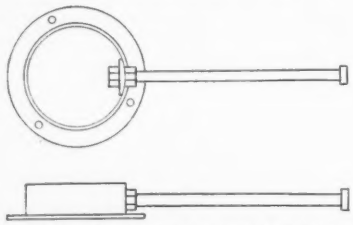
Later I put it on a Buckeye engine, the piston rod of which was worn down ⅛ in. leaving a swell on each end and having been sprung by water, it had a bow of fully ⅛ in. in it. This packing ran day and night on this engine, making 150 r.p.m., and one packing lasted 13 mo.

The water seal space not only provides a water space, but it provides a space to take care of the expansion and permit the packing section to yield to irregularities of the rod.

CHARLES B. RISLEY.

Emergency Ladle for Babbit or Soft Metal

A SMALL LADLE is something needed about the plant for running small babbit bearings. Recently in the absence of one, something in the line of a substitute had to be found in a hurry. The sketch shows how one was rigged up from the cast-iron body of an old steam



LADLE MADE OUT OF OLD STEAM GAGE BODY

gage. A long bolt was run through the tube opening and held firmly by two nuts, making a very satisfactory handle. The other small openings were plugged, affording a practical ladle for small amounts of soft metal. In a pinch there is always an old gage that will answer the purpose for getting out of the difficulty, for, due to the many purposes to which a small ladle can be put, it is the easiest thing to get lost and the hardest thing to find.

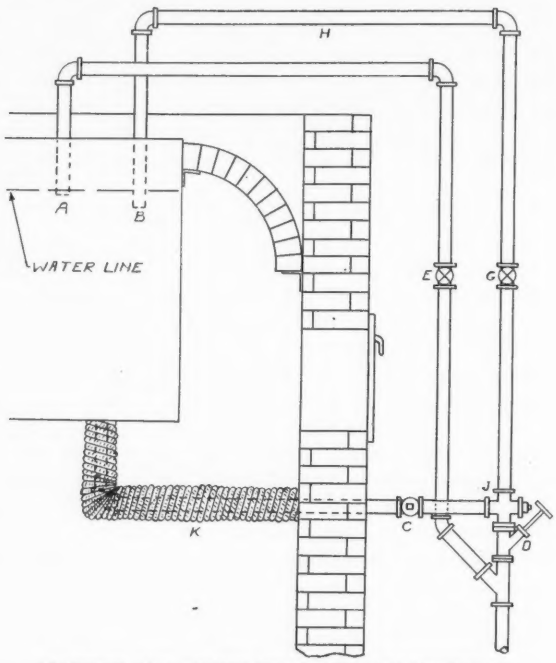
FRANK W. BENTLEY, JR.

Combined Blowoff and Circulator

A COMBINATION circulating and blowoff arrangement somewhat out of the ordinary is illustrated herewith, a surface skimmer blowoff being included.

It will be noted that the surface skimmer inlet at A is set at the water level, while the circulating pipe inlet at B is below the water level. Sometimes this pipe is so installed that the inlet end is always in the steam space, the result being nearly no circulation, as the only water to circulate will be the steam which is condensed in pipe H. The plug valve C is left open at all times, unless repairs are necessary to some of the other valves or pipes.

The plug J should be of brass, lubricated with oil and graphite when screwing it in. A double thickness of ¾-in. asbestos rope wound around the blowoff, at K,



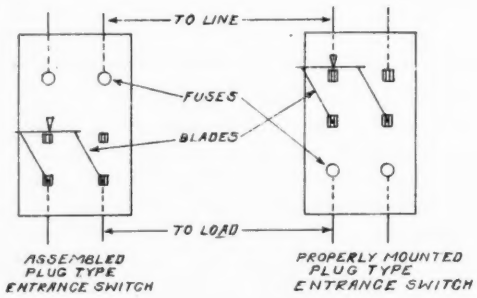
BLOWOFF AND CIRCULATING PIPE ARRANGEMENT

makes a safe, easily applied, easily removed, inexpensive pipe protector. The use of valves E, G and D is obvious.

JAMES E. NOBLE.

The Proper Way to Mount Entrance Switches

WHILE MANUFACTURERS have, for the past three or four years, made entrance switches reversible, such switches generally reach the purchaser assembled so that the fuse end is electrically charged when the switches are installed.

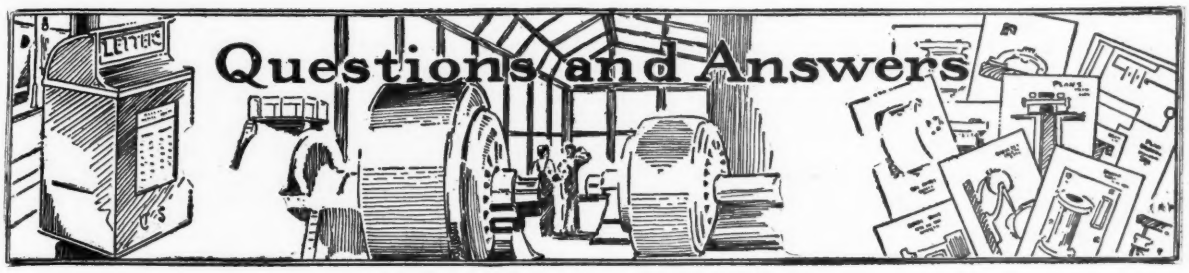


SKETCHES SHOWING METHOD OF REASSEMBLING ENTRANCE SWITCH TO MEET SAFETY REQUIREMENTS

It is only a few minutes' work to turn the blades over as shown in the accompanying sketch so as to eliminate any danger from shocks when renewing fuses.

JOHN F. WINN.

STEEL AND iron prices show a gradual rise during the past few weeks.



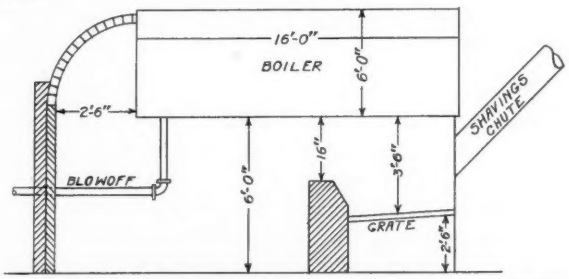
What Causes Leaky Tubes?

In the woodworking plant where I am employed we have two 72-in. by 16-ft. horizontal return tubular boilers and use the refuse for fuel, the shavings being blown into the furnace.

These boilers were installed secondhand in 1918 and I have had all kinds of trouble with leaky tubes. Previous to this, we had 18-ft. boilers and experienced no trouble.

We reflued these boilers in June, 1919, and again in 1920, and have rolled tubes as often as once a month, but at times they would hold from 60 to 90 days.

I have tried blowing the shavings under one boiler only and firing the other one by hand, and while I have not had as much trouble with the hand-fired one, it still continues to leak considerably. The tubes in this boiler have been rolled three or four times since June, 1920.



DIMENSIONS OF BOILER AND SETTING FOR BURNING REFUSE

While I think that the greater part of our trouble comes from the blower, I fail to understand why we experienced no trouble with the 18-ft. boilers.

The accompanying sketch shows the boilers and setting. The settings are in good condition and the boilers show no signs of oil in them. B. C. D.

Flue Gas Analysis

I WOULD BE pleased to have you give me a reply to the following questions:

1. For a certain coal consumption, say 2500 lb. per hr., in a furnace, what will the chimney gases weigh? What will be the volume?

2. With 15 per cent CO_2, how many pounds of air are being used per lb. of coal?

3. With a well designed economizer in the path of the flue gases, how many pounds of water would be heated per minute from 120 deg. F. to 230 deg. F., with a flue gas temperature of 550 deg. F.?

J. M. S.

ANSWERS

THE WEIGHT of flue gases resulting from the combustion of coal under a boiler is dependent upon the quality of the coal, the degree of air excess, and the degree of completeness of combustion.

Assuming a coal having the composition: carbon 70, hydrogen 10, ash 10, and water 10 per cent, burning completely with theoretical air requirements, then the following relations hold:

By weight, 12 parts of carbon plus 32 parts of oxygen give 44 parts CO_2, from which the weight of oxygen required for 0.70 lb. of carbon may be found from the proportion, $X : 32 :: 0.70 : 12$, from which $X = 1.88$ lb. and the weight of CO_2 is 2.57 lb.

Similarly, 4 parts hydrogen plus 32 parts oxygen give 36 parts water vapor and $X : 32 :: 0.1 : 4$ from which $X = 0.80$ lb.

The total oxygen required is then $1.88 + 0.80 = 2.68$ lb. Air contains 77 per cent nitrogen and 23 per cent oxygen by weight, so that the total weight of air required is $2.68 \div 0.23 = 11.65$ lb. and the weight of the dry flue gases is $2.57 + 2.68 \times 77 \div 23 = 2.57 + 8.96 = 11.53$ lb. per lb. of coal. If 2500 lb. of coal are burned per hour, the weight of flue gases per hour will be $11.53 \times 2500 = 28{,}850$ lb.

Now assuming 50 per cent excess air: $CO_2 = 2.57$ lb., $O_2 = 0.5 \times 2.68 = 1.34$ lb., $N_2 = 1.5 \times 8.96 = 13.45$ lb., and the weight of the dry flue gases is $2.57 + 1.34 + 13.45 = 17.36$ lb. per lb. of coal $= 17.36 \times 2500 = 43{,}400$ lb. per hr.

Since CO_2 is the only new gas found in the dry flue gases, and since one volume of CO_2 is obtained from one volume of oxygen, the volume of the dry flue gases, reduced to initial conditions of pressure and temperature, is the same as that of the air entering.

The total weight of air entering is $2.68 \div 0.23 = 11.65$ lb., for zero excess, and for 50 per cent excess $11.65 \times 1.50 = 17.45$ lb.

Assuming the air to be at a pressure of 14.7 lb. per sq. in. and having a temperature of 60 deg. F., under which conditions the specific volume is 13.05 cu. ft., the volume would be $13.05 \times 11.65 = 152$ cu. ft. per lb. of coal for zero excess or 228 cu. ft. for a 50 per cent excess.

At flue gas temperature the volume will be greater by an amount $(459.6 + T) \div 519.6$. Assuming T to be 500 deg. F., we find that the volume $V = V_1 (459.6 + 500) \div 519.6 = 1.845\ V_1$, which amounts to 282 and 411 cu. ft. for zero and 50 per cent excess respectively.

The total volume per hour is then 750,000 and 1,025,000 cu. ft. for theoretical requirements and 50 per cent excess. The increase in volume due to the drop in pressure is small and need not be considered.

2. The weight of dry flue gases resulting from the combustion of coal may be determined from the following equation

$$W = 240 \div \text{per cent } CO_2$$

where 240 is the product of 11.5, the weight of air for

theoretical requirements; and 20.9, the per cent of CO_2 resulting from the complete combustion of carbon with theoretical air requirements.

This equation gives weight of air per pound of carbon; to obtain weight per pound of coal, multiply by the per cent carbon in the coal.

If we assume a coal having 75 per cent carbon, the weight of the dry flue gases per lb. of coal with 15 per cent CO_2 is

$$W = 240 \div 0.15 \times 0.75 = 12 \text{ lb.}$$

3. In a well designed economizer, the amount of water that can be heated from 120 to 230 deg. F. with a drop in flue gas temperature from 550 to 400 deg. F. may be found from the following equation:

$$W_1C_1(t_0 - t_1) = W_2C_2(t_2 - t_3)$$

Where W_1 = weight of water, C_1 its specific heat, unity, W_2 weight of flue gases, C_2 their specific heat, which may be taken at 0.25, and t the temperatures as quoted.

The weight of air, with 50 per cent excess, from problem 1, is $17.45 \times 2500 = 43{,}600$ lb., then

$$W_1 = W_2C_2(t_2 - t_3) \div C_1(t_0 - t_1)$$
$$= 43{,}600 \times 0.25\ (550 - 400) \div 1.00\ (230 - 120)$$
$$= 1{,}635{,}000 \div 110.0 = 14{,}900 \text{ lb. per hr.}$$

Centrifugal Pump Operation

IN ANSWER to the question concerning centrifugal pump operation which appeared on page 971 of the Oct. 1 issue, I would say that there is no danger, neither would any injury result from closing the gate valve in the discharge of the centrifugal pump. If, in accordance with standard practice, the check valve on the discharge line is between the pump and gate valve, it is effort wasted to shut the gate valve. Although a gage on the pump discharge would come up to full discharge pressure, in fact, about 5 lb. over, with the discharge valve closed, the actual horsepower consumed would be low with the impeller simply churning and if the service were low pressure, a load might be thrown back on the motor, if started with the gate valve open before the motor was up to speed, thereby causing a tendency to throw off the belt or to injure the motor.

The horsepower input of a centrifugal pump is due to the impulse imparted to the water in passing through, and were the strainer plugged up the effect would be the same as running light, or if only partially stopped up, you would be pumping less water and therefore use less power.

THEODORE HAIGHT.

Testing Ammonia for Purity

WILL YOU kindly give me directions for testing anhydrous ammonia for purity? W. T.

A. Directions for conducting a simple qualitative test for determining the purity of ammonia, we quote from Siebel's "Compend of Mechanical Refrigeration."

"Place ⅛ oz. of pure chloroform and 4 oz. of the aqua ammonia in a separating funnel with glass stopper and stop cock. Agitate thoroughly by shaking. Then allow to settle. The chloroform will settle in the bottom and will have taken up the impurities. If the chloroform is now drawn off into a small porcelain dish and evaporated, any impurity will remain, recognizable by its pungent odor.

"Chloroform has an affinity for these impurities greater than the ammonia, consequently they will leave the ammonia and take up with the chloroform. Chloroform being heavier than ammonia, if you allow the mixture to stand a little while, it will settle to the bottom of the flask and carry down with it the impurities, if there are any, in the ammonia. Draw off the chloroform through the glass tube at the bottom of the separating flask. The chloroform can be distinguished from the ammonia on account of the different color. The demarcation between the strata of ammonia and chloroform will be clearly defined. Draw off the chloroform, and be careful to draw off no ammonia with it, into a small porcelain dish. The chloroform, being exposed, will evaporate, and being more volatile than the impurities which characterize the ammonia, the impurities will be left. They can be detected by their characteristic smell.

"There are other ammonia tests, the so-called acid tests, as follows:

"Take 10 cubic centimeters ammonia, dilute with 50 cubic centimeters distilled water, then add 20 cubic centimeters concentrated nitric acid, chemically pure. The mixture will remain permanently colorless, if the ammonia is pure.

"Take 10 cubic centimeters ammonia, dilute with 25 cubic centimeters water, add 50 cubic centimeters, dilute one to five sulphuric acid and cool the mixture. Then on addition of 2 cubic centimeters of 0.01 normal permanganate of potash; the red color produced should remain for 15 min."

Phase; Pounds Steam Per Horsepower-Hour

I WOULD appreciate having the following questions answered in your Questions and Answers department:

1. What is the meaning of the terms "phase" and "frequency" as applied to an electric circuit?

2. How many pounds of steam constitute a horsepower? J. C.

A. An electric current which flows back and forth at regular intervals in a circuit is called an alternating current. When the current rises from zero to a maximum, returns to zero, and increases to a maximum in the opposite direction and finally returns to zero again it is said to have completed a cycle. For convenience a cycle is divided into 360 deg. Any point in the cycle is spoken of as a certain phase. Thus when the cycle is half completed, it is said to be at the 180 deg. phase; when one-fourth completed, at the 90 deg. phase. The maximum value in one direction is reached at the 90 deg. phase, and in the other direction at the 270 deg. phase. The number of times this cycle takes place in one second is called the frequency of the current. Thus a current which rises to a maximum in each direction 60 times a second is said to make 60 cycles per second, or to have a frequency of 60.

2. Pounds of steam in a boiler or a pipe line, or even rate of flow in pounds per minute can no more be expressed as so many horsepower than can the amount of water in a pond be expressed in this unit. True, if this water is allowed to flow from the pond to some lower level, it has potential possibilities of producing power; this property is not inherent in the

water but depends on the use made of it. Power is defined as the rate of doing work. Obviously then, work must be performed if power is to be produced, and water in a pond does no work.

Steam flowing in a pipe at the rate of so many pounds per minute does no work except in overcoming friction or resistance to flow. It does, however, represent work done in generating the steam or work that may be done by the steam in expanding.

From the first point of view, a boiler horsepower is defined as the equivalent to the generation of 34.5 lb. of steam per hour from a feed temperature of 212 deg. F., at atmospheric pressure or at 212 deg. F. As 970.4 B.t.u. are absorbed in this process per pound of steam, 1 lb. hp. equals $970.4 \times 34.5 = 33{,}479$ B.t.u. per hour.

Suppose, now, that dry and saturated steam is generated at a pressure of 200 lb. abs. from a feed temperature of 100 deg. F., then the heat supplied per pound is $H - q$, where H is the total heat (from steam tables) and q the heat of the feed water above 32 deg. which equals $t - 32$ where t is the feed temperature. The heat supplied is $1198.1 - 100 + 32 = 1130.1$ B.t.u. per lb. Then $33{,}479 \div 1130.1 = 29.6$ lb. per hr. represents one boiler horsepower.

From the other point of view, one engine horsepower equals 33,000 ft. lb. per min. or 2545 B.t.u. per hr. Assuming that the steam expands to a pressure corresponding to the feed temperature, the Carnot cycle efficiency would be 33.5 per cent and the heat required would be $2545 \div 0.335 = 7600$ B.t.u. per hp.-hr. One engine horsepower would be represented by $7600 \div 1130.1 = 6.72$ lb. of steam per hour under these conditions. If the engine operates with a Carnot cycle ratio of say 40 per cent, $6.72 \div 0.40 = 16.8$ lb. of steam per hour represents one indicated horsepower.

If the total heat of this steam above 32 deg. F. could be converted into power, $2545 \div 1198.1 = 2.12$ lb. of steam per hr. would represent 1 hp.

We see then that under these conditions 29.6 lb. of steam per hour represents a boiler-horsepower and 16.8 lb. an engine horsepower. From this comparison it will be seen why a 100 hp. boiler, for instance, operating at rated load, is able to furnish steam for an engine developing 175 hp. The difference lies principally in the fact that there exists a dual standard for horsepower.

Lentz Engine Valve Setting

WILL YOU kindly inform me as to how I should proceed to set the valve of a Lentz engine?

A. Correct setting of the high pressure steam valves which are under the influence of the governor can be checked up in the following way. The side shaft is turned until the eccentric rods stand at right angles to the slide block. If the governor is now opened and closed from minimum to maximum position, the cam lever should show a scarcely perceptible motion. This is the correct position for lead, and the valve spindle has to be so adjusted that the roller just touches the curve of the cam, and that with the least motion of the side shaft, the valve will begin to lift.

The correct position of the valve may be determined by turning the valve stem a fraction of a turn until such position is found where the cam will engage roller with an easy and smooth effect without jar and noise.

All the other eccentrics are clamped on the shaft, and can be easily turned in any direction. By turning the low pressure steam eccentric forward, the lead is increased, and cutoff decreased. When turning the exhaust eccentric forward, release and compression are increased.

By shortening the eccentric rods on the steam valves, lead and cutoff are increased. By lengthening the exhaust eccentric rods, release is earlier, and compression decreased.

Power Requirements for Increased Compressor Capacity

WE HAVE a 10 by 22-in. double-acting ammonia compressor direct connected to a 12 by 36-in. Corliss engine operating under 100 lb. pressure. The compressor operates between a head pressure of 200 lb. and a back pressure of 22.5 lb.

We are thinking of removing the bushing from the ammonia cylinder, making it 11.5 by 22 in. instead of 10 by 22 in., but first we would like to know if the steam side will have enough power to pull the load under these conditions. J. O. R.

A. In order to be able to answer your question, it will be necessary to make a number of assumptions, as you do not give us complete data.

First, we will assume a cross connected machine having a flywheel of sufficient weight to carry the ammonia end over the peak pressures. Assume also that the pressures given are gage and that the engine exhausts to atmosphere.

The work, W, done in the ammonia cylinder per pound of vapor handled, the vapor at the end of compression being dry and saturated, is given by the equation

$$W = (t - t_1) \times h_1 \div T_1.$$

The temperature of discharge, t, corresponding to 200 lb. pressure, is 100 deg. F. The temperature in the expansion coils t_1, corresponding to 22.5 lb. back pressure, is 9 deg. F. T_1 equals $460 + t_1$ and h_1 is the heat of evaporation at the suction pressure, 22.5 lb., and is equal to 550 B.t.u. (from ammonia tables).

Substituting these values in the work equation, we find,

$$W = [96 - 9] \times 550 \div [460 + 9]$$
$$W = 102 \text{ B.t.u. per lb.}$$

The volume of the cylinder, V, neglecting the clearance, is equal to

$$V = 0.7854 \times d^2 \times l \div 1728$$

where d and l are respectively the bore and stroke in inches. Evaluating this equation, we get

$$V = 0.7854 \times 11.5^2 \times 22 \div 1728 = 1.32 \text{ cu. ft.}$$

At a pressure of 22.5 lb., the specific volume of ammonia is 0.1353 lb. per cu. ft., consequently the weight of ammonia in the cylinder per stroke is $0.1353 \times 1.32 = 0.179$ lb., and the work per stroke is $0.179 \times 102 = 18.2$ B.t.u., or multiplying by 778, the number of foot pounds equivalent to one B.t.u., we find the work done to be 14,200 ft.-lb.

Assuming now that the indicated horsepower of the engine is 140 per cent of the actual power output of the compressor (a figure given by Siebel as representing fair practice), we find that the work done per stroke in the steam cylinder, W_1,

$W_1 = 1.4 \times 14{,}200 = 19{,}850$ ft.-lb.

The work done here is also equal to P L A, where P is the mean effective pressure, L the stroke in feet, and A the area of the piston in sq. in. Knowing L and A, we solve for P. Substituting the known values, we find

$P = W_1 \div L A$

$= 19{,}850 \div (3 \times 0.7854 \times 12^2) = 58.6$ lb. per sq. in.

To determine the cutoff necessary under these conditions, we resort to a table compiled from Mariotte's law of steam expansion in a cylinder. The ratio of the mean effective pressure to the absolute initial pressure is found to be $58.6 \div 115 = 0.51$, which we find corresponds to a cutoff of approximately 20 per cent. Owing to the discrepancies which exist in the actual card, this figure may have to be increased somewhat.

Thus we can say that the engine will be able to handle the additional compressor capacity by cutting off at this point.

Absorption Ice Machine Capacity

WILL YOU kindly give me a rule or the method which should be used in computing the refrigerating capacity of an absorption ice machine? M. R.

A. The refrigerating capacity of an absorption ice machine may be figured from the following equations: Capacity

$$R = C \times r \div P_2$$

where R is the capacity in B.t.u. per min., C is the weight of liquid ammonia (anhydrous) pumped per minute, r is the refrigerating effect per lb. of ammonia, and P_2 is the pounds of rich liquor per pound of anhydrous ammonia.

$$r = h_1 - (t - t_1)s$$

where h_1 is the heat of evaporation at the temperature t_1 in the expansion coils, t is the temperature of the condenser, and s is the specific heat which equals

$s = 1 - 555 \div [460 + (t + t_1 \div 2)]$

$P_2 = [(100 - a)\ 100] \div [(100 - a)\ c - (100 - c)\ a]$

in which a and c are the percentages of strength of the weak and rich liquors respectively.

As a capacity of 288,000 B.t.u. per 24 hr. or 200 B.t.u. per min. is equivalent to one ton of ice melting capacity, the capacity of the machine in tons per 24 hr. may be found by dividing R, in B.t.u. per min., by 200.

Induction Coil vs. Transformer

WHAT IS an induction coil and in what way is it analogous to a transformer? For what purpose is it used? READER.

A. Fundamentally, the function of the induction coil is similar in many respects to that of the transformer. Transformers are used on alternating-current circuits to raise or lower the voltage. The most important use to which they are put is in power circuits to change the potential. For this purpose, they are of relatively large capacity. Current and potential transformers, so called, are of small capacity and are used for instrument work in connection with power circuits.

An induction coil is really an open core transformer using, instead of an alternating current, an interrupted direct current. Its purpose is to create high voltages and the current resulting is of little or no consequence. In ordinary ignition work for internal combustion engines, the voltage obtainable, with one or two dry cells, is in the neighborhood of 10,000 to 15,000 v. In wireless telegraphy practice, when high potentials were in vogue, pressures of 100,000 and 150,000 v. were common.

By closing the interrupter contact on an induction coil, we have in effect a transformer, of very low efficiency, it is true, on account of the high reluctance of the magnetic circuit, but by means of which the potential of an alternating current may be stepped up.

Weights of Equivalent Volumes of Flue Gases

SUPPOSE YOU have a volume of oxygen weighing 1 lb. and equal volumes of hydrogen, nitrogen, carbon monoxide and carbon dioxide; what will be the weights of these gases, assuming the same temperature and pressure in each case? C. M. S.

A. The weight of these gases having a volume equal to that of 1 lb. of oxygen may be determined from the general gas equation; $pV = MBT$, where p = pressure in lb. per sq. ft., V = volume in cu. ft., M = weight in lb., B is a constant determined by experiment, and T = absolute temperature. B has the following values:

Oxygen	48.249
Hydrogen	765.86
Nitrogen	54.985
Carbon monoxide	55.142
Carbon dioxide	35.09

If temperature and pressure are constant, $M \div M_1 = B_1 \div B$. Comparing oxygen and hydrogen $1 \div M_1 = 765.86 \div 48.249$, from which $M_1 = 48.249 \div 765.86 = 0.0630$ lb. The other values are found to be, nitrogen = 0.8775 lb., carbon monoxide = 0.8750 lb., and carbon dioxide = 1.3750 lb.

Boiler Feed Pump Balks

IN OUR plant there is an open feed water heater and a pump supported on the same foundation. Whenever the feed temperature reaches 180 deg. F., the pump refuses to function. The heater stands 5 ft. 6 in. high. What is the cause of this trouble and how can it be remedied? Should the heater be raised and, if so, how much? G. F.

A. We assume that this is a reciprocating pump, in which case either the valve springs are too stiff, or the suction line is too long or too small or has too many obstructions, such as elbows, etc.

The remedy which we would suggest would be to use lighter valve springs and larger suction line, or to connect a stand pipe to the suction pipe close to the pump, venting the top of the stand pipe to atmosphere. This gives the benefit of a steady head right at the pump and equalizes the flow through the suction line.

If the boiler feed pump is of the centrifugal variety, 5½ ft. is scarcely enough head on the suction; most builders recommend from 8 to 12 ft.

Crank Case Leak

IN ANSWER to L. C.'s question on page 1022 of the Oct. 15 issue in regard to elimination of oil leakage from a crank case, I would suggest that he carefully remove all grease and oil from the exterior surfaces by washing with caustic and then apply three coats of good shellac.

F. J. ELLIOTT.

Power Plant Operation Number

SPECIALIZED ISSUE FOR JANUARY 1, 1922

THIS ISSUE has been planned as a daily help for the operating engineer. It will be filled with data, and suggestions for planning, installing and operating power plant machinery of all kinds, as well as power equipment for driving machinery in shops and factories.

BOILER ROOM

THE BOILER ROOM will be the point of "take off," considering the details of daily operation and inspection; then repairs, replacements, monthly inspection and over-hauling. Special attention will be given to proper proportion and construction of furnaces, to economy in ash removal, to stoker operation and to repair of furnaces.

Auxiliary apparatus of the boiler room will take up pumps, injectors, feed-water heaters, economizers and superheaters.

Leading from the boiler room, the second general division will treat on piping and allied apparatus, provision for draining, expansion, supports, insulation, durable joints, valves and fittings.

ENGINE ROOM

NEXT the engine room, to look into the details of engines and operation, including lubrication, care and renewal of bearings, packing of rods, pistons and joints, adjustment of valves, valve motion and governors, how to change speed, how to equalize power between the ends of a cylinder and between the cylinders of multiple expansion engines, causes of racing and how to stop it, cure of vibration and methods of inspection and overhauling. Like full and complete consideration will be given for steam turbines.

Condenser equipment will cover types of condensers, modern systems of tube arrangement, proper care and repair.

HEATING SYSTEMS

GENERAL requirements to get a satisfactory heating system will be discussed, but the greater emphasis will be placed on the essential details, including reducing and vacuum valves, water seals, connections to radiators, proper sizes of piping and amounts of radiation, avoidance of air binding and water hammer, location and drainage of receivers, and disposition of condensate.

ELEVATORS AND CONVEYORS

CARE of elevators will have a special section, dealing with the operating machinery and controls, care and renewal of ropes, proper capacities and speeds.

Conveying systems for coal, ashes and factory materials will take up the driving mechanism, details of different types of conveyors, including bucket, link, scraper and belt.

REFRIGERATION

A MAIN division will be concerned with refrigerating plants, both compression and absorption systems, details of machinery and its care, condensers, ammonia storage and handling, treatment and handling of water and the arrangement of freezing tanks, the brine system and its upkeep, valves, joints, packings, piping and the location and maintenance of cooling coils.

HYDRAULIC, COMBUSTION ENGINE AND COMPRESSED AIR MACHINERY

UNDER hydraulic plants, the main features discussed will be flumes, gates, screens, casings, runners, governors, gearing, draft tubes.

For internal combustion, engines will be taken up, details of the fuel system, the cooling system, and lubrication.

For air compressors the details of the compressor itself, air intake, valves, cylinders,, intercooler, jackets, receivers, piping system, packing, lubrication, operation and adjustment of unloading devices and automatic controls will be the chief subdivisions.

ELECTRICAL MACHINERY

A MAIN division will take up electrical machinery, with subdivisions on dynamos, motors, electric circuits, batteries, transformers and tests.

The section on dynamos will cover care of brushes, commutators, bearings, sparking troubles and remedies, grounds and short circuits, repairs on armature and field windings, parallel operation, synchronizing and the thorough overhauling of machines.

Motors will have similar careful consideration, also sections on starting and speed control methods and apparatus.

Electric circuits will include requirements for safety of inside wiring, pole lines, conduit systems, switchboards, arrangement of circuits and tests for grounds, shorts and insulation resistance.

How to operate batteries to get best results will include charging, frequency and rate; discharging, maximum rate, most effective rate and effect of overload; tests for voltage and specific gravity, inspection of cells, cause and remedy for buckling, sulphating and scaling, and the way to overhaul a battery, replace plates, wash out and renew solution.

Types of transformers and their construction and internal connections will be shown. Inspection and tests for condition of coils, connections, and insulating oil will be given in detail.

SPECIAL TESTS AND MEASUREMENTS

PLANT TESTS AND MEASUREMENTS will include such devices and methods as do not enter into regular operation and inspection such as alarm systems for water level, speed of engines, generator voltages; connection and use of wattmeters for a.c. circuits, artificial loading of machinery for tests, and emergency use of test instruments.

The best methods of operation will be secured from successful plant engineers and wide search is being made throughout the plants of the country for new ideas and for emergency kinks which have been successful in overcoming difficulties.

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Engineering Leadership

Not often do we step outside of the policy of letting the work of Power Plant Engineering speak for itself to our readers. But we believe that all members of this great family which is bound together by interest and pride in a common calling of the highest standing and importance to all industries, will feel a thrill of pride in knowing that esteem in which our paper is held by one of the greatest of engineers, a man who has been chosen for a commanding position in government, and whose judgment and accomplishments are trusted and heralded throughout the world.

"Pressure of official duties makes it impossible for me to address the members of the National Editorial Conference in Chicago as I should like to do. I have appreciated the opportunity given me in the monthly meetings we have held together in Washington to express the policies of the Department of Commerce with regard to some of the pressing industrial questions before us. We have indeed great problems yet to solve. I cannot but feel that if these problems are considered as human and not as material questions, we can find their solution. We are dealing with questions of railways, of farms, of shops and of instruments of commerce and industry; but in the background of every person's mind there is the fact that we are dealing not with mechanical things, but that we are concerned with the problems of men, women and children. There must be in our discussions of these matters the dominating thought that the better control of economic forces is in fact simply the better comfort of the country. Those several organizations within the Department of Commerce which we have developed and set at work within the past few months are concerned in this spirit, and it is a fine augury of our industrial future to know that the programs and purposes of these various departmental activities have come from our manufacturers, merchants and engineers themselves. The editors of the business press have shown a fine spirit of service. Your opportunity for leadership is unique and unchallenged. Upon you rests in large measure the responsibility of the control of industrial thought and opinion in the detail of the industrial, economic and technical problems which confront us. I wish your conference every success in carrying forward your high and constructive purposes."

HERBERT HOOVER.

We feel that this message will also explain and justify the treatment on our editorial page of topics of economics and government somewhat outside the mechanics and engineering of power machinery; for, after all, an engineer is a man, usually an influential leader among his fellows, and each of us should feel his responsibility for being well informed for helping to establish a sound condition of industry, and for arousing his community—his associates—to a sense of their responsibility for good government.

The accompanying telegram was received by the National Conference of Business Paper Editors at a meeting in Chicago, and refers in part to the work of a committee of editors which for several months has worked with Mr. Hoover at his request in trying to solve the problems of getting industry into better condition, not only for the present, but for future continuance. It is a thoughtful message which we feel will be a welcome inspiration to our readers, and in that thought we pass it on to you.

Standard Method of Proportioning Heat and Power Expense Needed

Frequently we are asked, "what is the cost of generating a kilowatt-hour of electricity"? This seems, to the layman, a perfectly logical question and it is when confined to a single plant or a certain type and size of plant in one community. But the question is usually asked in a general way and, so put, no definite answer can be given.

Of course, after a plant has been put into operation the records should furnish data from which this cost can be calculated accurately and if they do not the system of record keeping is incorrect. A mistake frequently made, however, not only by laymen and owners of power plants but by engineers themselves, is to judge a power plant strictly on a cost per kilowatt-hour basis, and we still have many controversies between the advocates of the central station and the isolated plant largely because definite standard methods of calculating the heat balance in isolated plants have not been established and figures are juggled to suit personal prejudice.

Too few power plants that furnish exhaust steam for heating or industrial purposes are equipped with means for keeping a record or even estimating the value of their services in any direction other than that of electric power delivered to the switchboard. This condition has been the cause of many shifts from isolated plant to central station service and back again just in order to try out the different services and see which is the more economical. Such experiments are expensive as compared with the few instruments necessary for determining the needs of the plant.

In the article by George C. Cook in this issue is outlined a method for comparing economies in central stations, what is needed next is a basis upon which the value of the services of isolated and industrial plants can be compared.

Standard test codes have been established for practically all power plant equipment, uniform boiler laws have been passed in most of our states, regulations for electrical wiring construction are practically the same throughout the country, we have many standard shop practices and formulas used in design but when it comes to proportioning the expenses of an isolated plant between its power and heating load the engineer has no established standard to guide him and no matter what method he may employ he meets a controversy at every turn of the road.

With superpower zones being established and widespread recommendations made that small industrial power plants be shut down, it is highly important that a common basis of comparison be worked out as a definite guide to the users of power and heat.

Power Plant Slogans

Keep and Analyze Operating Records in Every Power Plant.
Develop Water Power Sites.
Promote Health and Safety in Power Plants.
Handle Coal and Ashes Mechanically.
Employ Engineers for Engineering Work.

Anger

By Dr. Frank Crane

THERE is no use telling any red-blooded man not to get angry.

Indignation is a natural flame that spurts up in the mind, upon certain occasions, as surely as gasolene burns at a lighted match.

All I say is—wait! Don't do anything till your heat is gone. Don't say words, fire the man, quit the job, nor pass judgments until your brain has cooled down.

For most anger is the irritation of offended vanity. We think a lot of our opinion and when one sneers at it, it is as if he threw mud on our white duck trousers. We have a high notion of the respect due us, and when it is intimated that we are nobody we want to smash something to show we are somebody.

We are never angry, save when our pride is hurt. Anger is self-esteem on fire.

So, flare up, if you must, swear and break the furniture; it may do you good; but go up to your room to indulge in this relief, lock the door, and stay there until the storm blows over.

Never write a letter while you are angry. Lay it aside. In a few days you can come back at your offender much more effectually.

Don't transact business in heat. When you are "mad clean through" it is your sore egotism that is operating, and acts prompted by egotism are usually ridiculous. Hang up the matter for a few days, and come to it again when your intelligence is not upset by your feelings.

One of the best things to say is nothing. When you answer a man he gets your measure; when you keep still you have him guessing. The cool man, who has himself under control, always has the advantage over the hot man.

Even if you have to lick a man you can do much better if your head is clear of anger fumes. Wrath may lend a little extra punch to your blows, but self-control will plant them to better effect. Anger dulls your efficiency. What you do goes wild. You have a lot of energy, but no accuracy.

Anger makes chaos in your thought. You are a crazy man. What you think in the egotism of anger you will pay for in the humiliation of saner moments. Few good deeds have been done in anger, while all manner of crimes are due to the intemperance of wrath, such as blows, murders and war, "the sum of all villainies."

The first and greatest lesson to learn is to control temper, and, if your nature is touchy, to resolve to take no action until the blood is cooled. This is sound sense, sane ethics, good business.

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Patching Boiler Settings

THE LIFE of boiler settings can be prolonged by careful attention to patching when opportunity affords. Small cracks or open joints, if attended to before the brick or tile become loosened, will save a more serious repair job.

Large patches and other repairs using Hytempite as a binder for crushed fire brick or special granular refractories have been successfully made on many types of furnaces. These patches are troweled on and the surface of the patch coated afterwards with diluted Hytempite.

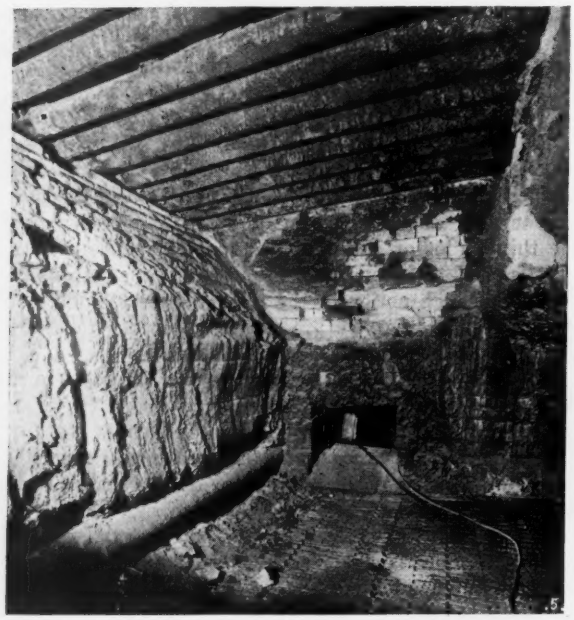


FIG. 1. CONDITION OF FURNACE WALL IN MIDWEST PLANT

All boiler settings will develop weak spots sooner or later. The average operating engineer realizes that a well applied patch with the proper materials may save a lengthy job of reconstruction—and a shutdown.

Many attempts have been made to repair side walls and arches of boiler settings. The results have often proved a failure and the operating engineer has been discouraged in his efforts to make a patch that will stay put.

A method of patching which has proven very successful in a number of central station and industrial plants is described and illustrated here.

Patching suspended horizontal surfaces or flat arches and the filling of deep and extended abrasions in side walls have been made with recognized success by using Hytempite as a binder for the refractory filling. Successful patches have been made even in cases where 6 ft. square of the side walls have been eaten away 6 or 8 in. deep. The brick work has been restored to its original thickness and the patch has stuck.

Where brick has spalled in the arch, the crevices have been filled and the arch restored to original alinement.

Hytempite requires no heat to effect a bond so that the newly applied patch can be built up in the crevice or hole and becomes an integral part of the structure.

Success in this work depends on the method of application as well as on the materials used.

As illustrating the bad condition of arch and walls, note Fig. 1 of the boiler setting in a large middle-west plant. Some of the suspended arch blocks are entirely gone and the brick work badly eaten away. Figure 2 is a companion picture to Fig. 1, taken when patching was partially completed to show the method of application.

In applying the patches, the clinker was first removed and the surface chipped and nicked until most of the glaze was gone and the original texture of the brick exposed. Care was taken in this work so that the bricks were not loosened. Then the entire surface to be patched was brushed until free from dust.

This surface was then well saturated with a thin milky wash of Hytempite and water as a primary coat which was quickly absorbed by the exposed brick surface.

The foundation for the patch consisting of a somewhat thicker mixture was then applied as a bonding coat. Where the surfaces were large, this was done in sections so as to insure a moist surface for applying the patching mixture.

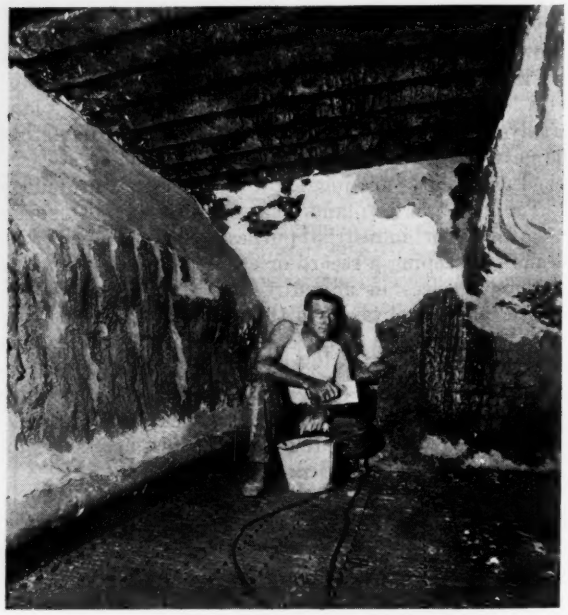


FIG. 2. METHOD OF APPLYING HYTEMPITE

The patching material consisted of diluted Hytempite to which Carbosand was added gradually until thoroughly mixed, the consistency being such that no free moisture showed when the mixture was squeezed in the hand.

Care was taken to apply the patch while the foundation coat was still moist.

After the patching was completed on all large and small surfaces, it was allowed to set for about an hour before applying a final surfacing of the same mixture as used for the bonding coat. The object of the final coating was to fill pores and small voids and give a smooth surface that would resist pitting action of flames and hot gases.

The patching was done under the supervision of Quigley Furnace Specialties Co., 26 Cortlandt St., New York.

New Propeller Type Blowers

WITH the exception of low duty ventilating fans, propeller blowers have in the past been used almost exclusively for undergrate draft on hand fired boilers or with chain grate and overfeed stokers, on account of their low efficiency at higher pressures. The advent of the Coppus Vano blower, a new product of the Coppus Engineering & Equipment Co., has extended the field of the screw-blade propeller type of blowers, which delivers the air parallel to the axis. They operate against pressures up to 8-in. water and, therefore, can be employed where, until now, only centrifugal blowers could be used. Their efficiency, it is claimed, runs up to 80 per cent and the power consumption at constant speed is practically unaffected by variations in air delivery or pressure.

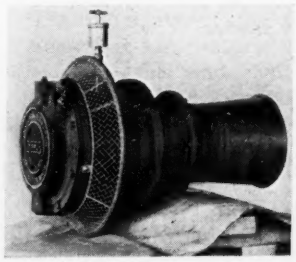


FIG. 1. TURBINE DRIVEN COPPUS VANO BLOWER
FIG. 2. GUIDE VANE CASING OF NEW BLOWER

The distinguishing feature of this new blower is the stationary guide vane of peculiar design beyond the propeller. The air current leaving the propeller is radially sub-divided by the individual guide vane blades and taken up by them without shock. The guide vane blades which have a curvature, increasing in the direction of the rotation of the propeller, concentrate the air current and give it a further acceleration inside of the stationary guide vane so that a considerable part of the pressure is produced in the latter. A large part of the end thrust is thus taken up by the stationary guide vane casing. The air streams, into which the flow of air has been sub-divided by the guide vane blades, leave the guide vane casing, on account of the kinetic energy, slightly rotating and convergent toward the axis so that the smallest section of the air flow is reached beyond the guide vane casing.

On account of the three principal features enumerated above, these blowers are adapted to many uses, as: undergrate or forced draft for hand fired boilers, chain grate, overfeed and underfeed stokers; induced draft; main and individual room or tunnel ventilation for mines; air heating and drying installations; cooling of electric motors and generators; ventilation of factories, boiler rooms, ships, tunnels, etc.

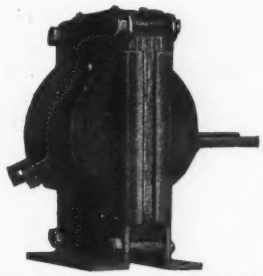
The design of these blowers is such that the air enters and leaves the blower parallel to the axis. They are high speed machines, which require a comparatively small driving unit. As a result of these features and the compactness of design, the blowers can readily be installed in pipe lines, which is a distinct advantage in ventilating, heating and drying systems. They work with the same effect and efficiency when installed at the entrance or at the end of the air duct operating as blowers or exhauster, respectively, and by placing several of them in series equi-distant apart in long pipe lines or air duct, the losses through leakage are reduced to a fraction of the losses at high pressure necessary where only one blower is used.

They also allow the reversing of the direction of rotation which changes the direction of the flow of air through the blower. In such a case, they deliver from one-third to one-half of their normal capacity.

The most noteworthy feature connected with these blowers is the constant power consumption at constant speed practically unaffected by air delivery and pressure, thus eliminating damage due to overloading the driving element which might result with other types when pressure increases or air delivery is abnormally high.

New Type Indoor Current Transformer

GOOD ACCURACY is the feature of the type K current transformers just brought out by the Westinghouse Electric & Manufacturing Co. This type is listed for ammeter, wattmeter or watthour meter use, but may also be used for operating relays and circuit breaker trip-coils, where the load at 4 amp. does not exceed 25 volt-amperes at 25 cycle or 65 volt-amperes at 60 cycle.



ACCURATE CURRENT TRANSFORMER FOR INSTRUMENTS AND RELAYS

As shown in the illustration, the transformers are arranged with the primary leads on opposite ends of the coil, an arrangement well adapted for general service conditions, including switchboard mounting. The three-wire type K transformer is designed for use with watthour meters on three-wire distribution systems. The primary consists of three separate windings, one of which is connected in each outside wire of the three-wire system, and the secondary winding is connected to the watthour meter. When so connected, the watthour meter measures the total output of the system. The ampere rating refers to the current in the outside wires.

Brown Steam Jet Ash Conveyor

THE STEAM jet ash conveyor which has recently been placed on the power plant market by the C. W. Brown Engineering Co. possesses features of design that are radically different from the present prevailing views. Among engineers, it is well recognized that the chief difficulty with the pneumatic type of ash

handling systems has been at the turns. The usual practice has been to use long sweeps. This company claims that long sweep elbows cannot be justified, because the ashes travel so fast that they hug the side of the pipe, no matter how long the curve. The only feasible way to change the direction of flow is with a short 90-deg. elbow or tee, where the ash is swirled and thoroughly mixed with the air which carries it on.

As the short section of pipe immediately following the tee is the only part that wears rapidly, it is made of extra heavy material, 2 in. thick. It has been the experience of the designers of this system that nothing is to be gained by turning a section in order to equalize the wear and so these sections are designed to remain in place.

The steam jet nozzle is made of steel, accurately turned to the correct contour and case hardened to reduce wear to a minimum. It is screwed into a flanged fitting which is fastened to the tee with cap screws. The result is that only a few minutes are required to change jets.

Ash holes are provided with floor plates, where the pipe is below the boiler room floor, or with a funnel hopper where it is run below the ash pits.

As a rule, the ash is not wetted before being discharged to the receiving bin. It has been found that ordinarily the condensate of the steam used for blowing furnishes enough moisture to lay the dust. A sprinkler is provided, however, at the end of the line in case the water from the steam is insufficient for the purpose.

In the ordinary installation where the distance from the boilers to the ash bin is not excessive and where the number of turns is reduced to a minimum, one nozzle ¾ in. or less in diameter, is usually sufficient. Where the distance is greater or where there are a number of turns, more jets will be required, but as a rule they may be of a smaller size.

A New Control Valve

A CONTROL valve ingenious in design and construction and possessing a number of extremely valuable operating characteristics has recently been developed by the National Regulator Co. and is now being placed on the market.

This device has a number of applications, many of which will suggest themselves when its operation is understood, but is essentially designed for use in controlling the steam to stoker or blower engines, in connection with damper regulation in boiler rooms. As is well known, in the control of stoker or blower engines, it is often desirable to limit the opening and closure of the control valve between very narrow limits. It is also desirable that such limits may be varied at will and with the minimum of effort to accommodate the varying conditions of load which prevail in many plants.

These requirements are taken care of by the new National Control valve in a very simple but effective manner. Any desired range of valve opening, from closure to full opening, throughout the movement of the regulating lever can be secured by the mere adjustment of a thumb screw.

As shown in the accompanying illustrations, the device consists of a balanced type of piston valve controlled by a cam arrangement, comprised of a curved steel cam, the movement of which imparts an up and down movement to a spring-return follower. The curved steel cam is a true arc of a circle, one end of which is pivoted to an arm of the cam yoke as shown at A, Fig. 1, while the opposite end is adjustable with

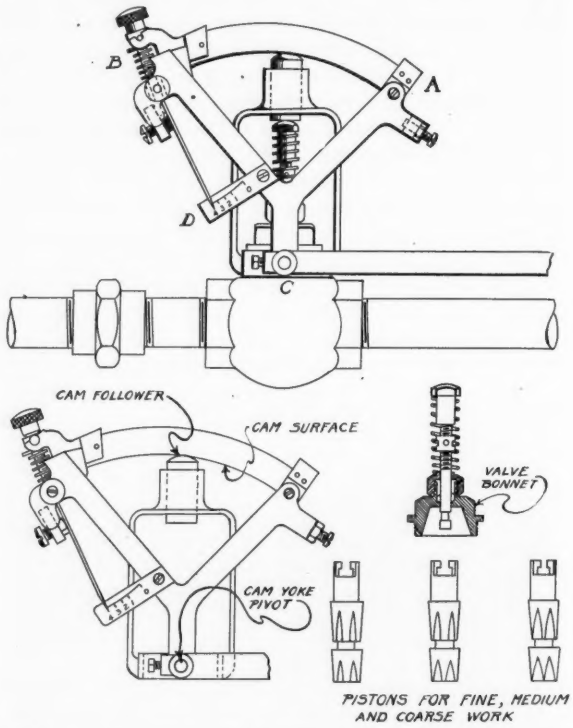


FIG. 1. DETAILS OF NEW NATIONAL CONTROL VALVES

reference to the other arm of the cam yoke as shown at B. The cam yoke is pivoted at C so as to be capable of an angular movement of approximately 70 degrees.

The adjustment of the cam is indicated by a pointer moving over a graduated scale as shown at D. When this pointer is set at zero, the edge of the cam is a

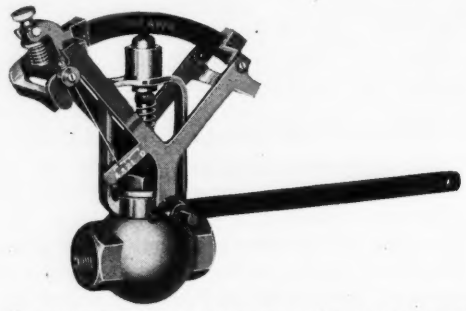


FIG. 2. PHOTOGRAPH OF CONTROL VALVE COMPLETELY ASSEMBLED

true arc of a circle, the center of which is the point at which the cam yoke is pivoted. As the adjustment is increased, however, one end of the curved cam is raised, causing the radius between the yoke pivot and the inner edge of the cam to be progressively increased as this radius is measured between the two extremities of the arc. As a consequence of this variable radius,

when the yoke cam is rotated back and forth through its angular distance of travel, an up and down motion is given to the follower which actuates the piston valve.

In this manner a proportional opening and closing of the valve is secured throughout the movement of the lever. The flow of steam is controlled by a simple up and down closure of the valve. The valve is regularly equipped with a medium piston, but a coarser and a finer one are also provided as regular equipment, owing to the fact that it is almost impossible for the company to anticipate the operating conditions under which the many regulators are sold; with three different sized pistons furnished, one will always be suitable. These pistons may be substituted for one another by simply removing the cam yoke and the valve bonnet—the work of only a few moments.

The valve when used in combination with the control of dampers by a graduating acting damper regulator, provides excellent control of combustion.

It is recommended that this valve be installed on a bypass rather than in the direct line to the engine, to facilitate changing of piston when necessary.

The simplicity of the device and its positiveness of operation are features which are of considerable value. The cam and cam follower are of hardened steel, thus reducing wear on these parts to a negligible amount. The valve can be installed in any position and is adaptable for use over a wide range of pressures.

Handling Coal in Storage

TO PROVIDE proper facilities so that coal may be purchased in large quantities when the market is favorable and stored against times of shortage and high prices is one of the most important problems confronting the power plant engineer. To be able to store large quantities of coal, it is necessary, first, that a suitable space be available, and, second, that there be some method of handling the coal, from the cars to the storage pile and from the storage pile to the coal handling apparatus in the plant itself.

Probably one of the simplest and most economical methods of handling coal to and from storage is by means of either the scraper or cableway system. As coal is stored chiefly as a safeguard against shut-downs, a storage system is generally operated only at intervals. This means that the carrying charges on the machinery and structures, especially interest and depreciation, constitute a large item in the cost per ton of handling the fuel, if the storage equipment is complicated and costly to install. The scraper system being simple and comparatively inexpensive, insures low fixed charges. The simplicity of this system also makes for low maintenance costs.

Such an installation, as made by Sauerman Bros., consists simply of the bottomless scraper to which are attached two cables, one inhaul and the other outhaul, both of which connect to the hoisting drum at the operators' station. The outhaul cable passes over a sheave; attached, by means of a bridle cable, to any one of a number of back posts, located along the far edges of the coal pile, and back to the operating drum.

This system of handling coal can be suitably arranged for large storage piles on any available, irregular shaped property. As the equipment can easily be moved or relocated, it can be used temporarily on any detached vacant land that might at other times be used for other purposes. In the event of a fire at any point in the pile, the apparatus can be shifted to dig out the hot spot immediately and thus prevent its spreading.

This method can be used to advantage where it is desired to store a reserve supply of coal adjacent to the boiler plant, for the purpose of augmenting the bunker storage. In this case, facilities for receiving the coal from cars, crushing, elevating and distributing to bunkers, are usually provided. Surplus fuel is delivered to the storage yard from this conveyor system by suitable spouts or an auxiliary conveyor. The scraper takes this coal and delivers it to any desired point in the yard. When this reserve is drawn upon, the direction of operation is reversed and the coal is reclaimed back to a hopper which feeds back to the conveying system of the plant or within reach of a grab bucket which serves the conveying system. If a trestle is available, cars may be dumped and the scraper used to distribute the coal. A pit may be put in beneath a siding and the cars dumped into the pit, from which the scraper can transfer the coal to the yard.

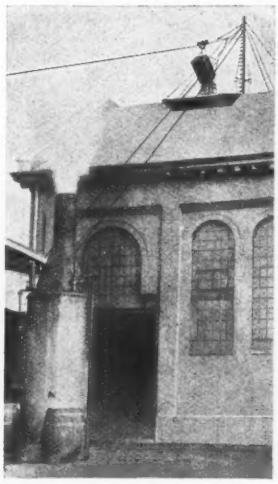


FIG. 1. SAUERMAN CABLEWAY CONVEYOR CARRYING A LOAD OF COAL FROM THE STORAGE PILE

FIG. 2. CABLEWAY CONVEYOR BUCKET BEING DUMPED INTO THE BOILER ROOM BUNKERS

Under certain conditions, where coal is stored under water in a pit near the boiler room for instance, a cableway conveyor may be used to better advantage. In this system, it is possible to handle the coal direct to the boiler house bunkers without the aid of a supplementary conveyor or elevator. The accompanying illustrations serve to show a cableway system conveying and dumping a load of coal.

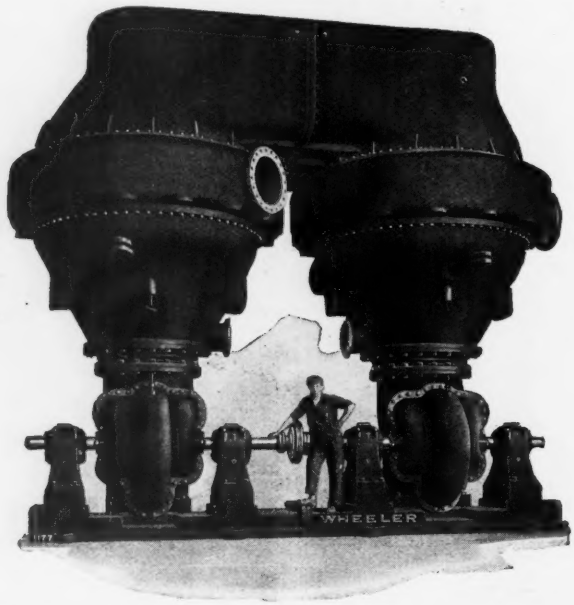
This cableway system consists primarily of a scraper bucket attached to a carrier, running on an inclined track cable which is supported at the upper end through tension blocks by a mast and anchored at the lower end to either a movable tail tower or through bridle cables to tail posts. A load cable is attached to the front of the bucket which performs the operation of loading the bucket and conveying it along the cable to the dumping point. The bucket is raised or lowered

over the coal pile by winding or unwinding the track cable by means of a hoist drum. Either of these systems can be operated by one man.

Features of New Twin Jet Condenser

HEREWITH is illustrated the latest large jet condenser unit manufactured by the Wheeler Condenser & Engineering Co., which is of special interest on account of its size and the operation of auxiliaries. It was built to serve a 20,000-kw. General Electric turbine at the Hauto, Pa., plant of the Pennsylvania Power & Light Co. Designed for 28 in. vacuum with 75 deg. injection water, it will handle a total of 25,000 g.p.m., or 12,500 g.p.m. for each removal pump.

Twin jet condensers are frequently furnished for serving large units because they have greater flexibility, are easier to handle, and reduce the headroom. Each condenser body, as shown, is mounted over a separate



TWIN JET CONDENSER FOR A 20,000-KW. TURBINE

removal pump, and will also be provided with separate air pumps, so in times of light load or with cold injection water, only one-half of the unit need be operated, resulting in a saving of 50 per cent of the normal power. When in full operation, the water levels in the two bodies are equalized by means of a connecting pipe, flanges for which are the two lower ones shown on the condenser bodies opposite each other.

Both a geared turbine and motor are furnished to drive the removal pumps of this unit—each being large enough to drive both pumps alone—so that the load can be divided as required to maintain the heat balance of the plant by producing more or less exhaust steam, according to the amount that can be utilized economically for heating feed water. These are not shown in the photograph, as they were sent direct to the plant, and could not be assembled in the shop where the photograph was taken. A feature of the pump drive is a magnetic clutch, which unites the shafts between the inside shaft bearings. It permits either pump to be driven independently of the other, without interfering with continuous operation, when only one-half of the condenser is to be operated.

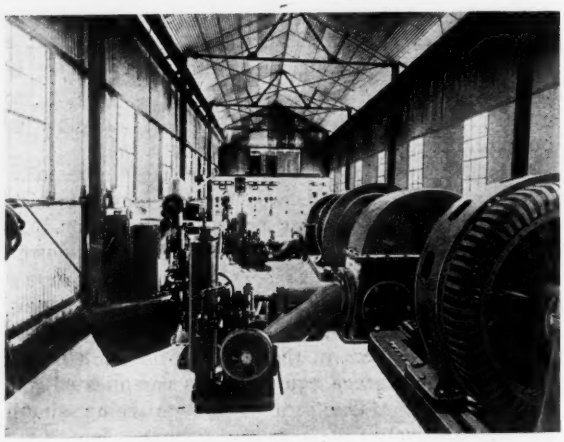
As will be noted from the photograph, an expansion joint is provided between each condenser body and its removal pump. By this arrangement, the condenser body is suspended from the turbine nozzle, while the removal pump and its driver are mounted upon a rigid foundation; the expansion joint absorbing temperature strains. An expansion joint provided in this way eliminates the large expansion joints usually placed between the turbine and the condenser.

Another point of interest is the vertically split casing of the horizontal double suction tail water pump serving each condenser. When it is necessary to inspect or repair the rotor or any of the wearing parts, it is simply a matter of removing the bolts, and uncoupling the rotor. Before this design was developed, considerable time and effort were required to get at and remove the rotor.

This huge condensing unit will be served by two large Wheeler steam jet air pumps of the combined surface intercondenser and heater type, and two turbo air pumps, each pump being large enough for one condenser. Boiler feed make-up is circulated to the intercondenser and heater of each steam jet air pump.

Guantanamo Electric Co. Plant

THE GUANTANAMO ELECTRIC CO., of Cuba, which supplies power for the cities of Guantanamo, Jamaica and surrounding sugar plantations and whose hydroelectric station on the Guaso River is shown here, was organized with a capitalization of $800,000 in 1916. Eduardo J. Chibas, formerly a railroad official of Cuba, is president of the company.



INTERIOR VIEW OF HYDROELECTRIC PLANT IN CUBA

At the present time power at the station is developed by two Allis-Chalmers 560-hp. impulse wheels, making a total of 1120 hp. direct-connected to 470 kw., 2300-v., three-phase, 60-cycle Westinghouse alternators. There are also two exciters, one driven by a 60-hp. impulse wheel and the other by an electric motor. Each has sufficient capacity for the two generators. Two 500-kw. transformers of the oil insulated self-cooling type, raise the voltage from 2300 to 23,000 v. for transmission. The hydro plant is located about 12 mi. from the city of Guantanamo.

John F. Robertson

AFTER an illness of only nine days, John F. Robertson died on Oct. 19 at the Suburban General Hospital, Bellevue, Pa. For many years Mr. Robertson has been nationally known as one of the leading manufacturers and dealers in engineering specialties having been the founder and president of the John F. Robertson Co. of Pittsburgh, which will continue business under the policies which have been so well established.

Mr. Robertson was born Nov. 18, 1873, at Forneth, Perthshire, Scotland, and for the last 33 yr. has been a resident of Pittsburgh. He was president of the Lawrenceville Bronze Co., vice-president of the Superior Brick Co. and president of the Neville Lubricating Co. As an active church worker and a leader in many lodges, both social and professional, Mr. Robertson made many staunch friends who mourn the loss of a great benefactor.

News Notes

THE EXECUTIVE COMMITTEE of the National Safety Council at its first meeting following the Tenth Annual Safety Congress elected the following vice-presidents for the National Safety Council: David S. Beyer, Liberty Mutual Insurance Co., Boston, vice-president for service to members; B. F. Tillson, New Jersey Zinc Co., Franklin, N. J., vice-president for industrial safety; F. A. Davidson, Dwight P. Robinson Co., New York City, vice-president for sectional activities; C. B. Scott, Bureau of Safety, Chicago, vice-president for local council; David Van Schaack, Aetna Life Insurance Co., Hartford, Conn., vice-president for public safety; W. E. Worth, Chicago Safety Council, secretary and treasurer. W. H. Cameron, formerly secretary-treasurer of the National Workmen's Compensation Service Bureau, New York City, was elected executive secretary of the National Safety Council. Mr. Cameron, who on Nov. 1 will assume charge of the headquarters of the National Safety Council at Chicago, returns to a post which he held from the creation of the council in 1912 to 1919. Sidney J. Williams was re-elected chief engineer of the council. C. W. Price, formerly general manager, will assist the National Safety Council as a special consultant in public safety.

THE POWDERED COAL DEVELOPMENT CORPORATION has been organized with headquarters at Omaha, Neb. This company controls the Pruden patents for the burning of pulverized coal in the western half of the United States. Byron B. Oberst is president of the new corporation. The board of directors includes R. M. Robertson, A. E. Hall, Jos. C. Weeth, J. J. Dodds, Bert Phillips and Irving H. Arey.

CHAIN BELT CO. has opened offices at 735 Ellicott Square, Buffalo, N. Y., and has announced the appointment of T. E. Cocker as district manager of that territory.

THE VULCAN FUEL ECONOMY CO., Chicago, announces the removal from the Transportation Building, to Machinery Hall, 549 West Washington Blvd., Chicago, where it is much better situated with reference to the trade with which it is affiliated. Announcement is also made that the withdrawal of George L. Simonds, long president of the company, has resulted in the election of a new directorate which has elected Dr. Eugene Murray-Aaron, president. Dr. Murray-Aaron has been secretary of the company for some years and is inventor of some of the improvements in its gas analysis instruments.

NASHUA Machine Company, Inc., announces the opening of a branch office in the Monadnock Building, Chicago.

J. C. SANDERS has been appointed manager for the Clark-Brooks Company at Charlotte, N. C., succeeding C. H. Thomas.

W. H. NICHOLSON & Co., Wilkes-Barre, Pa., has appointed R. D. Clapp & Co. as its agent at Cleveland, O., and O. R. McBride as Chicago agent.

S. P. REES, formerly with the Pittsburgh Filter & Engineering Co., has been made manager of the municipal filtration department of the International Filter Co. of Chicago.

D. K. CHADBOURNE has been appointed manager of the New York office of the Westinghouse Electric International Co. Mr. Chadbourne came to the Westinghouse Co. through the George Cutter Co. before it was affiliated with the Westinghouse.

THE PULVERIZED FUEL Department of the Quigley Furnace Specialties Co., Inc., has been acquired by The Hardinge Co., 120 Broadway, New York. The experience and manufacturing facilities of The Hardinge Co. enables it, with the present equipment and augmented staff, to extend further the activities of the Quigley pulverized fuel system.

PROFESSOR JACQUES CAVALIER, rector at Toulouse and an authority on metallurgical chemistry, comes to America as the result of arrangements for an annual exchange of professors of engineering and applied science between French and American universities. This plan, which corresponds to the exchange professorships in academic students, will be put into operation this fall. Professor Cavalier, who is now at Columbia, and whose visit is another link in the world movement for engineering solidarity started by the organized engineers of America, England and France, will divide his time during the academic year among the co-operating institutions, Columbia, Harvard, Yale, Cornell, Johns Hopkins, Massachusetts Institute of Technology and the University of Pennsylvania. The American universities have selected as their representative for the first year Dr. A. E. Kennelly, professor of electrical engineering at Harvard and M. I. T. This exchange plan proposes an annual exchange of a professor in the various branches of applied science and a steady interchange of advanced students between France and America in these fields.

Books and Catalogs

AMERICAN ELECTRICIANS' HANDBOOK; by Terrell Croft. Second edition, revised and enlarged; 823 pages, pocket size, flexible, 900 illustrations; New York, N. Y., 1921.

The book is a reliable, useful handbook for wiremen, contractors, linemen, plant superintendents and construction engineers. It has been thoroughly revised since the first edition and much new material has been added.

It is essentially a handbook for reference and does not go into design. It aims to give the practical man the facts on apparatus, materials and installation which he needs in his daily work. Only enough theory is presented to explain why certain things should be done in certain ways.

The illustrations are well executed and are prepared in such a way as to be of real value to the reader in forming a better conception of the problem under consideration.

The book is divided into six sections, the titles of which are respectively as follows: Fundamentals, Generators and Motors, Outside Distribution, Interior Wiring, Transformers and Electric Lighting.

BULLETIN No. 122 entitled "The Thermal Conductivity and Diffusivity of Concrete," by A. P. Carman and R. A. Nelson, just issued by the Engineering Experiment Station of the University of Illinois deals with certain experimental work carried on at the Engineering Experiment Station with the object of determining these properties for a number of specimens representing certain standard mixtures. During the last 10 yr. the composition and methods of preparation of concrete mixtures have been studied and standardized, and present investigators have had the advantage of dealing with concrete mixtures which can be described much more definitely than was possible a few years ago. The results of only a few determinations of the thermal conductivity of concrete have been published previously, and to a large extent these lack definiteness in regard to the composition and method of preparation of the material. Copies of this Bulletin No. 122 may be had without charge by addressing the Engineering Experiment Station, Urbana, Ill.

THE POWER SPECIALTY CO. has just published a new 32-page catalog on superheated steam and the Foster superheater. In the fore part of this bulletin, there is an up-to-date discussion of the advantages of using superheated steam. This covers the benefits and savings to be expected with superheated steam on reciprocating engines and steam turbines. The Foster patented superheater construction is also fully explained and pictures and drawings are shown of modern installations of this superheater in all well known types and makes of boilers. This same bulletin also introduces a new type of superheater which utilizes radiant heat from the combustion chamber of the boiler. Ordinary forms of superheater construction cannot do this because the rate of heat transfer would be too high. A new special armored surface has made it possible to apply superheating elements of this kind to any type of water tube boiler. The construction and advantages of this type are fully covered in the new bulletin, No. 300.

DESCRIPTIVE CATALOG of "Steel Mixture" products manufactured by McLeod & Henry Co., Troy, N. Y., was recently received. These include boiler door arches, firebox blocks, back combustion chamber arches, furnace arches, blowoff pipe protectors, dutch ovens, fire clay and fire cement, and fire bricks of all kinds.

TWO NEW FOLDERS covering Nash and Jennings equipment as manufactured by Nash Engineering Co., South Norwalk, Conn., were lately received. One illustrates and explains the parts and action of the Nash Hytor air compressor and vacuum pump; the other, the Jennings return line pump, a turbine vacuum pump, boiler feed pump, and air separator, combined.

NORDBERG AND THE MINING INDUSTRY is the title of a new 9 by 12-in., 16-page and cover booklet issued by the Nordberg Manufacturing Co.

The booklet illustrates the plants of 15 mining companies, gives data concerning their production of copper, gold and silver, mentions the capitalization, assets and dividends of each plant, and briefly describes the important equipment, including the Nordberg apparatus, in use.

Copies will be mailed on request, to anyone interested in hoisting and motive power equipment for mines.

A LEAFLET describing Yarnall-Waring Co.'s recent development of a self-contained type WR CO_2 Recorder has just been received.

THE CONVEYORS CORPORATION OF AMERICA, Chicago, has issued a new folder describing its American air tight door for ash pits, boiler settings, coke ovens, core ovens, bake ovens, oil stills, dryers, retorts and kilns.

COOPER CORLISS Steam Engines Bulletin No. 54, just published, describes and illustrates up-to-date improvements in Corliss engine design, sizes ranging from 150 to 5000 hp.

Anyone interested in Corliss engines may receive a copy of this booklet by writing to The C. & G. Cooper Co., Mt. Vernon, Ohio.

BULLETIN No. 13 of the National Tube Co., of Pittsburgh, Pa., gives details of the construction of hammer-welded steel pipe, shows various uses and joints, and includes a full list of sizes, weights and pressures. At the end is a full discussion of flow of water in pipes, with charts, formulas and tables on properties of water, contents of tanks, horsepower of flow, strength of rivets, and areas of circles.

W. S. ROCKWELL CO., 50 Church St., New York, recently issued Bulletin No. 234—"The Continuous Heat-Treatment of Metals with Automatic and Semi-Automatic Furnaces"—which is the fourth of a series dealing with fundamentals that influence the quality and cost of heated products.

This bulletin illustrates practical applications of the principles outlined by the previous bulletins of this series, Nos. 230, 231 and 232.

THE NEW line of electric furnaces which has recently been added to the products of the Westinghouse Electric & Mfg. Co. is ably described and illustrated in catalog 9-C, which is being distributed. This type of furnace includes the multiple unit designed for use with heats of 1800 to 2000 deg. F. The small Hevi-duty furnaces of the multiple crucible type may be operated continuously at 2000 deg. F. Hevi-duty industrial furnaces with applications for annealing, hardening, drawing and enameling, are described in minute detail in this publication. A discussion of the characteristics of these furnaces is also given.

DESCRIPTION and price list of Superspeed belting, a dense fibered, high grade belting made by Superspeed Belting Co., of Boston, are given in a booklet lately received from that company.